LEVEL

R and D LABORATORY

TARADCCM

TECHNICAL REPORT

NO. 12391

DIGITAL TERRAIN SIMULATION

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by 2nd Lt STEVE CHARLES

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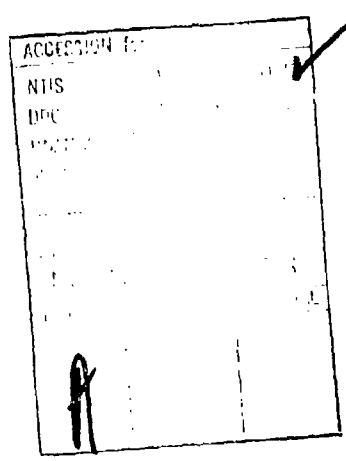
U.S. ARMY TANK-AUTOMOTIVE
RESEARCH AND DEVELOPMENT COMMAND
Warren, Michigan 48090

ABSTRACT

Road profiles available for digital terrain simulation at TARADCOM are cataloged. The terrain simulation program for the PACER 100/EAI 580 Hybrid computer system is described. The terrain simulation program was developed to better utilize the hybrid computing system when it is required to run several vehicles over known terrains at different speeds for varying lengths of time. The operator can interactively setup the test environment or feed in a prepared paper tape. Terrains are stored on disks and vary from profiles of actual test courses to synthesized forcing functions. Development and operation of the program are described and possible future refinements are explored.



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PREFACE

This report describes digital terrain simulation at TARADCOM. The aim of the simulation is to subject a vehicle to a vibration environment similar to what it might experience in the field. This is accomplished by placing the vehicle on hydraulic actuators which move up or down depending on the electrical voltages applied. Electrical signals are usually supplied by an analog computer. Digital terrain simulation is accomplished using a digital computer to produce voltages in digital-to-analog (D-to-A) components on the analog computer.

Reference 1 describes how several actual terrain profiles were digitized for use as input to vehicle simulation studies. These profiles and others (about 40 in all) were transferred to disk storage for rapid on-line use by the digital computer.

The report describes how these terrain profiles were converted to wheel displacements and how the wheel displacements are applied to a vehicle.

1. CONVERSION OF TERRAINS

The terrain elevations are in feet and were measured at one, three, six, and twelve-inch intervals. Most terrains had 600 or less data points and this was chosen as a practical limit. All elevations are greater than zero and some reach a height of almost eight feet. This presented a problem because the actuators currently available at TARADCOM only have a 12-inch span. It was solved by taking into account the fact that long uphill or downhill trends provide very little input to the vibration response of a vehicle.

The detrending routine is fairly straightforward and is presented in Appendix A. The program takes out long uphill and downhill trends by drawing a line through the slope which has no data point more than six inches away.

Figure 1

TERRAIN ABOVE ZERO

The slope is then moved down to level, with the starting and ending points equal to zero.

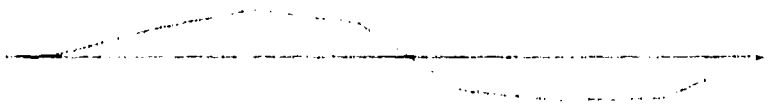


Figure 2

DETRENDED TERRAIN

In this way the relative slopes between data points are preserved while keeping within the physical limits of the actuators. The only discontinuities exist at the pivot points of the detrended segments. The subroutine finds the longest segments in order to minimize the number of discontinuities.

Now that the terrains fit an actuator it is necessary to calculate the motion of a wheel traversing the data points. The wheel trajectory routine described in reference 2 obtains the position of the bottom of a rigid wheel traversing a non-deformable terrain. The resulting wheel trajectories for each terrain were then dumped to paper tape and loaded into separate disk files on a digital/analog hybrid computer.

2. SIMULATION PROGRAM

The program has basically three phases:

1. Terrain Input - Subroutine "INPUT"

2. Bay Setup - Subroutine "BAYS"

3. Terrain Output - Subroutine "RUN"

In the terrain input phase, the operator is asked the names of the files on disks containing terrain data. The first record ofthe disk file has the number of samples and sample interval in inches followed by records containing the scaled fraction data. In scaled fraction data there are 15 bits of information plus a sign bit. For example:

0000000000000000 = 0 volts = 0 feet
1000000000000000 =-9.9999 volts = -.5 feet
0111111111111111 = 9.9999 volts = .5 feet

After all terrains have been input, the operator is asked how many bays will be run. The operator must supply the number of axles and their dimensions, which terrains will be traversed, the angle of traversal, the desired speeds, and distances for each bay.

The subroutine BAYS translates these parameters into control variables which are later used by subroutine RUN. To get an idea how this is done, picture a jeep mounted on four actuators. If the wheel signal were applied to all four actuators simultaneously the jeep would have only vertical accelerations being input into it. Now if the back

wheel signals were delayed a small amount of time there would be angular motion between the front and rear of the vehicle (called pitch). When wheels on both sides of a vehicle see duplicate paths the vehicle is said to be traversing a "washboard"-type terrain. Traversing the washboard at an angle causes a time delay from when a wheel on one side of the vehicle hits a point to when a wheel on the other side hits it. This produces a side-to-side motion called roll.

BAYS will translate the speed and angle of attack into relative delays between the wheels of a vehicle. In this way vertical acceleration, pitch, and roll can be produced in a vehicle in the laboratory.

In the output routine, RUN (see figure 1), the data channels are all more-or-less independent. The subroutine scans the channels and subtracts the time since the last scan from each channel timer. If the timer reaches zero, a new data point is output. A channel may change to a new terrain only after a complete run of the current terrain. This is to insure that the output of one terrain is zero before a new terrain is introduced. Channels common to a bay are sequential and the right rear wheel is identified as the LAST to finish the phase. This insures proper interwheel timing for the next phase. There is a two-second pause between phases to allow easy differentiation of terrains.

It should be noted that this setup allows two vehicles to use the same terrain. If one vehicle changes terrains, it should in no way affect another vehicle which might happen to be in the middle of a run.

Once the digital program is running, the hydraulics should then be turned up to whatever level is desired. To shut down, the hydraulic controllers should be brought to zero and the program terminated.

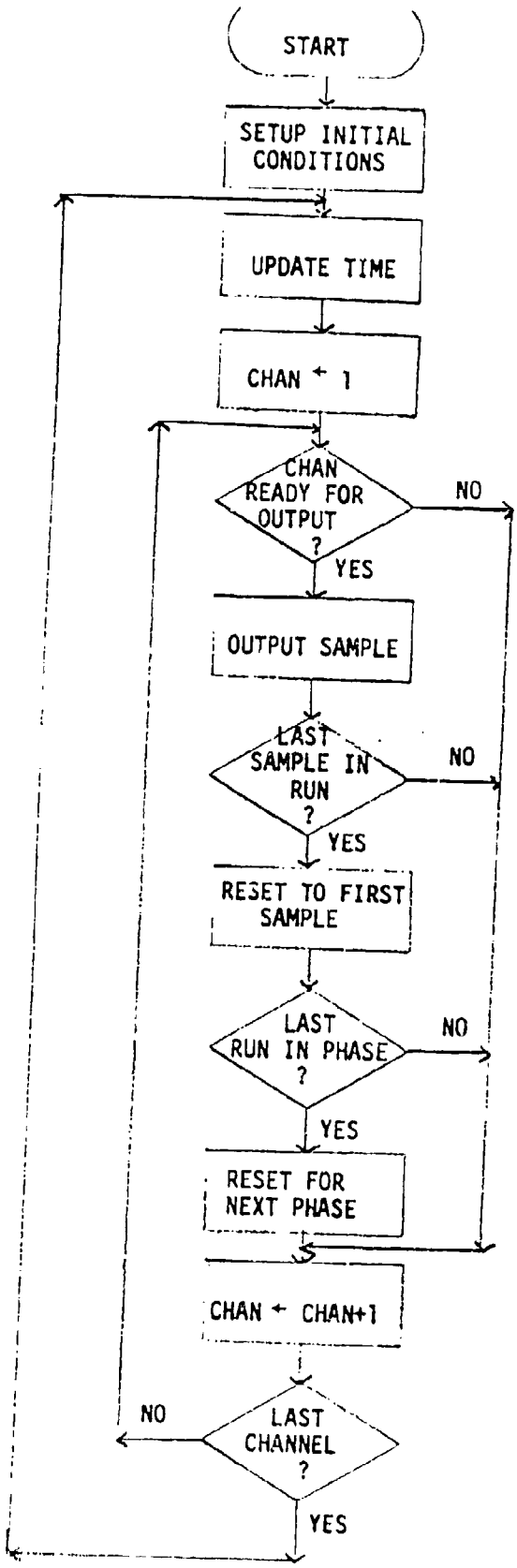

START
SETUP INITIAL CONDITIONS
SUBROUTINE TO OUTPUT TERRAINS
UPDATE TIME
CHAN ← 1
CHAN READY FOR OUTPUT ?
NO
YES
OUTPUT SAMPLE
LAST SAMPLE IN RUN ?
NO
YES
RESET TO FIRST SAMPLE
LAST RUN IN PHASE ?
NO
YES
RESET FOR NEXT PHASE
CHAN ← CHAN+1
LAST CHANNEL ?
NO
YES

Figure 3

3. FUTURE PROJECTS

a. The system currently has eight channels of analog wheel displacement data. This allows, for example, a three-axle truck and a one-axle water trailer or, say, a four-axle tracked vehicle by itself. If eight more channels were added, there would be greater flexibility in simulation scheduling. Three vehicles in the three bays would be virtually independent of each other and would not have to double up on data channels.

b. Due to the digital nature of the terrain simulation, the output is a staircase function as shown below in Figure 4.

Figure 4

STAIRCASE FUNCTION

This introduces high-frequency noise and is not very realistic. A straightline approximation as in Figure 5 is desired. There are two basic approaches to this problem.

Figure 5

LINEAR INTERPOLATION

1. Construct linear interpolators as shown below.

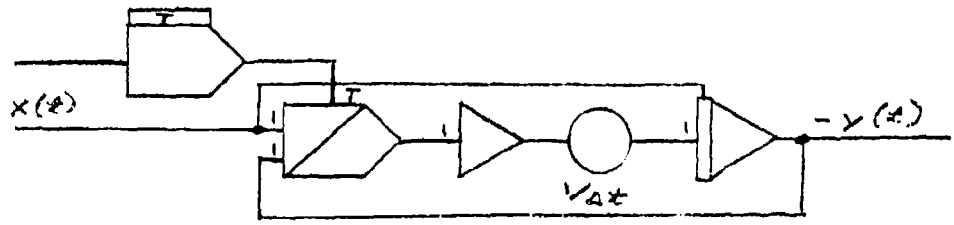


Figure 6

LINEAR INTERPOLATOR

The resources exist to construct only four of these and would necessitate changing the potentiometer settings for a bay each time it changed terrains. The effect of this would be to require all of the bays to run the same terrain at the same speed and for the same distance, which would limit the flexibility of the system.

2. As the number of data points is increased (by decreasing the sample interval) the staircase more closely approximates a straight line. All that is needed is to use Capacitance Limiting to smooth out the small increments.

This approach is currently being pursued but it is limited by the digital computer having only 16K of memory. The addition of 16K would allow a greater number of terrains in a test setup.

c. In a system with a large library of terrains such as this, it soon becomes desirable to modify or combine terrains for special applications. A system for updating or modifying terrains would be a future enhancement.

4. TERRAINS

On the following pages you will find plots of terrain profiles with detrended wheel trajectories below them. The actual wheel displacements are tabulated after each plot.

The RMS value is calculated by the following formula:

$$RMS = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (Yi - \bar{Y})^2}$$

where:

N = Number of terrain samples

$\bar{Y}$ = Average wheel displacement

Yi = Wheel displacement for sample i

The date on the plot is when the terrain was converted. The date on the tabulation is when the terrain was first stored on disk.

TABLE 1

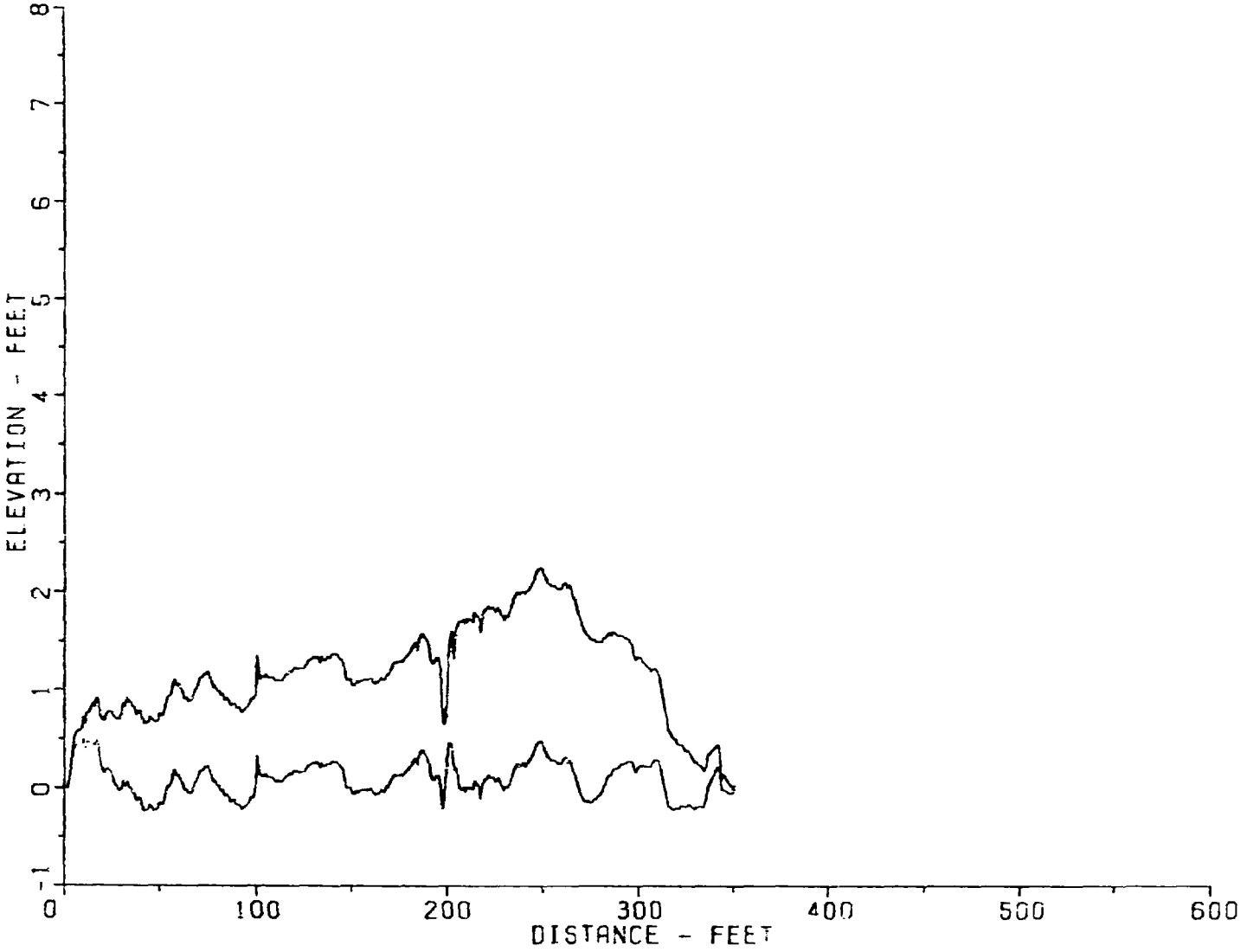
TERRAINS WITH CORRESPONDING FILE NAMES

TERRAIN	FILE NAME
Ft. Knox Mild	RD01
Ft. Knox Rocky	RD02
Synthetic Field	RD03
Ft. Knox Medium	RD04
Synthetic Rock and Log	RD05
APG Perryman III	RD06
APG Belgian Block	RD07
Six-Inch Sine Wave Course	RD08
Three-Inch Spaced Bump	RD09
RMS Equal One	RD10
Modified RMS	RD12
APG Terrain 10	RD13
APG Terrain 9	RD14
APG Terrain 11	RD15
APG Terrain 12	RD16
Houghton Data 3	RD17
Houghton Data 4	RD18
Houghton Data 5	RD19
Houghton Data 6	RD21
Houghton Data 7	RD22

TABLE 1

TERRAINS WITH CORRESPONDING FILE NAMES (CONT'D)

TERRAIN	FILE NAME
TARADCOM Wood Course	RD23
Ft. Knox CTA1	RD24
Ft. Knox CTA2	RD25
Ft. Knox STV1	RD26
Ft. Knox STV9	RD27
Ft. Knox STV4	RD28
APG 30	RD29
APG 29	RD30
APG 34	RD31
APG 35	RD32
APG 37	RD33
APG 32	RD34
APG 36	RD35
APG 34	RD36
APG 31	RD37
APG 29	RD38
Profile 4 APG	RD39
Profile 4 Chrysler	RD40



R001

Figure 7

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TABLE 2
R001

FORT KNOX MILD 1964 ADDED TO THE DISK ON 1.MAR.77

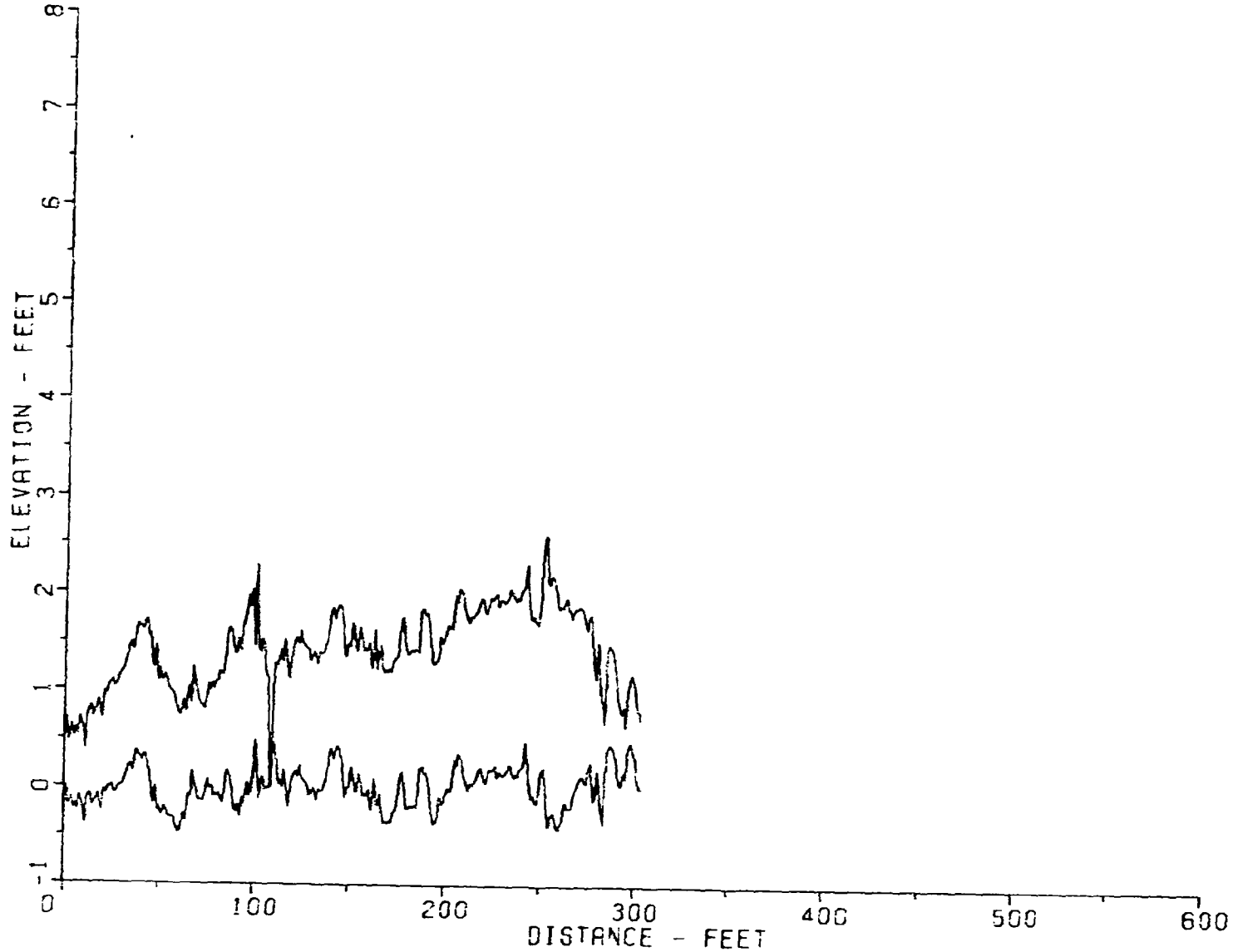
NUMBER OF POINTS = 351

INTERVAL IN INCHES = 12

ELEVATIONS IN FEET

POINT										
1	.00	-.01	.10	.23	.40	.44	.42	.39	.41	.40
11	.40	.48	.46	.48	.50	.42	.49	.44	.38	.38
21	.15	.19	.19	.17	.14	.07	.02	-.01	-.04	-.01
31	.07	.01	.07	.00	-.01	-.05	-.07	-.13	-.18	-.18
41	-.19	-.23	-.23	-.23	-.17	-.20	-.23	-.23	-.22	-.18
51	-.17	-.16	-.07	.01	.02	.03	.14	.18	.12	.13
61	.09	.04	-.02	-.01	-.06	-.05	-.03	.02	.06	.10
71	.17	.18	.19	.21	.23	.16	.13	.08	.08	.02
81	.02	-.03	-.02	-.07	-.06	-.09	-.14	-.13	-.12	-.17
91	-.17	-.17	-.22	-.20	-.18	-.16	-.13	-.10	-.10	-.07
101	.34	.15	.12	.11	.14	.11	.11	.10	.10	.07
111	.06	.08	.06	.06	.10	.12	.13	.16	.14	.16
121	.18	.18	.16	.17	.16	.18	.20	.24	.24	.25
131	.27	.25	.27	.21	.26	.22	.23	.26	.24	.27
141	.27	.28	.27	.23	.20	.21	.08	-.00	.00	.01
151	-.06	-.06	-.02	-.05	-.03	-.02	-.01	-.02	-.02	-.01
161	-.01	-.05	-.07	-.05	-.06	-.01	-.04	-.03	.02	.01
171	.06	.10	.14	.13	.13	.14	.12	.14	.17	.18
181	.21	.24	.28	.31	.24	.34	.39	.39	.35	.31
191	.26	.13	.08	.09	.13	.11	.01	-.22	-.19	.16
201	.47	.46	.45	.18	.20	.11	.01	-.02	.01	-.04
211	.00	.00	-.01	-.02	.07	.03	.03	-.11	.05	.00
221	.09	.13	.10	.12	.09	.07	.10	.06	.01	-.03
231	.01	.00	.06	.10	.19	.22	.24	.22	.24	.26
241	.22	.25	.26	.30	.33	.38	.45	.47	.49	.47
251	.41	.35	.31	.30	.28	.29	.27	.24	.26	.24
261	.30	.32	.26	.29	.25	.17	.13	.07	.00	-.07
271	-.10	-.13	-.14	-.12	-.15	-.14	-.11	-.12	-.09	-.07
281	-.04	.02	.03	.09	.13	.14	.19	.20	.20	.21
291	.24	.24	.26	.27	.28	.27	.26	.20	.16	.22
301	.23	.24	.22	.22	.21	.22	.22	.26	.29	.28
311	.27	.21	.10	.02	-.09	-.19	-.19	-.22	-.22	-.21
321	-.22	-.21	-.18	-.19	-.20	-.19	-.17	-.16	-.18	-.22
331	-.20	-.20	-.19	-.20	-.20	-.12	.01	.04	.10	.14
341	.18	.22	.21	-.02	-.02	-.03	-.05	-.08	-.05	-.05
351	.00	-1.00	1.12	.00	-.03	-.43	-.21	.00	-.16	-.33

RMS = 2.135 INCHES



R002

Figure 8

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TABLE 3
RD02

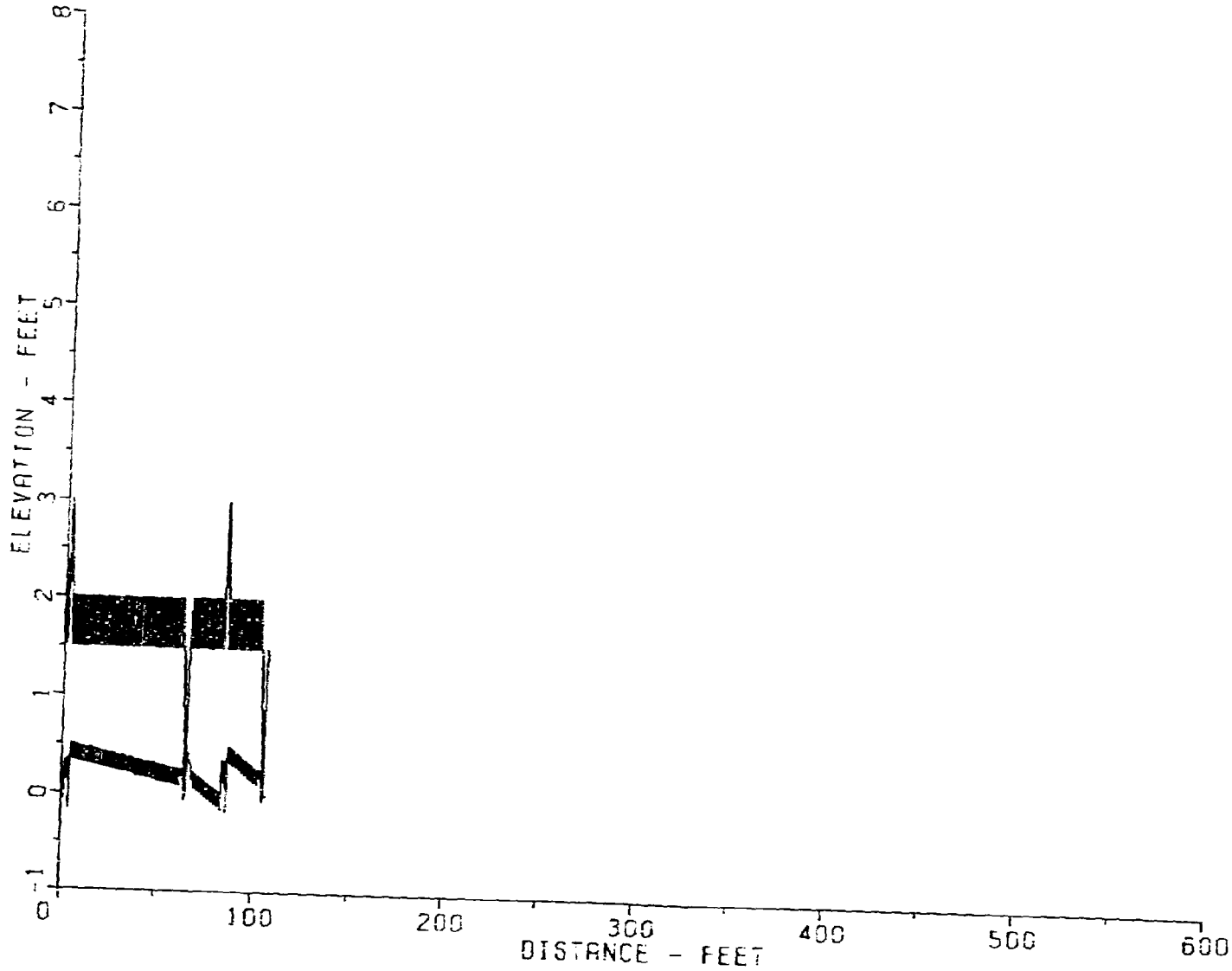
FORT KNOX ROCKY 1964 ADDED TO THE DISK ON 1-MAR-77

NUMBER OF POINTS = 303

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.19	-.17	-.11	-.23	-.16	-.24	-.10	-.19	-.23
11	-.39	-.15	-.09	-.08	-.20	-.16	-.14	-.08	-.20	-.25
21	-.04	-.08	-.02	-.02	.01	-.07	-.07	-.01	.01	.02
31	.04	.10	.17	.23	.24	.16	.27	.37	.34	.30
41	.27	.33	.34	.18	.16	-.08	-.17	.00	-.25	-.29
51	-.29	-.25	-.29	-.26	-.31	-.32	-.32	-.32	-.41	-.47
61	-.48	-.35	-.28	-.35	-.17	-.08	-.10	.17	.03	-.08
71	-.13	-.15	-.15	-.13	.01	.08	-.02	.00	-.10	-.08
81	-.10	-.07	-.13	-.17	.02	.17	.16	.09	-.09	-.24
91	-.26	-.18	-.30	-.11	-.17	-.08	.04	-.10	.00	.17
101	.48	.17	-.12	.07	.11	-.02	.00	.00	.13	.45
111	.46	.25	.03	.08	-.00	.16	-.00	-.20	-.08	.08
121	.15	.18	.12	.23	.12	.08	.05	.02	-.09	-.07
131	.08	-.07	-.13	-.02	-.04	-.02	.05	.09	.23	.38
141	.46	.29	.36	.43	.40	.29	.02	-.11	.00	.02
151	.20	.14	-.05	-.03	.15	.04	-.06	-.07	-.09	-.02
161	-.23	-.15	.10	-.17	-.18	-.07	-.25	-.37	-.34	-.37
171	-.34	-.36	-.28	-.23	-.16	.03	.13	.17	-.06	-.22
181	-.21	-.19	-.21	-.18	-.20	-.08	.20	.22	.15	.17
191	.10	-.09	-.31	-.38	-.35	-.26	-.19	-.17	-.15	-.08
201	-.01	-.03	-.03	.15	.30	.24	.35	.33	.21	.12
211	.05	-.02	.05	.02	.05	.08	.16	.22	.20	.08
221	.05	.13	.20	.18	.20	.23	.11	.17	.15	.12
231	.15	.19	.25	.23	.16	.12	.15	.13	.20	.23
241	.29	.28	.22	-.01	-.10	-.08	-.15	-.15	.03	.18
251	.21	.04	-.27	-.39	-.28	-.26	-.33	-.40	-.43	-.38
261	-.32	-.28	-.14	-.01	-.19	-.20	-.08	-.01	.02	.09
271	.12	.13	.05	.06	.21	.28	.18	-.18	-.39	.19
281	-.10	-.22	-.37	.04	.36	.43	.45	.45	.36	.24
291	.11	.03	.06	.17	.11	.37	.47	.48	.38	.29
301	.09	.10	.00	-1.08	1.12	.00	-.24	.52	.56	.56

RMS = 2.51M INCHES



RD03

Figure 9

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SYNTHETIC PILE F.H.G. 1964 ADDED TO THE DISK ON 1.MAR.77

NUMBER OF POINTS = 428

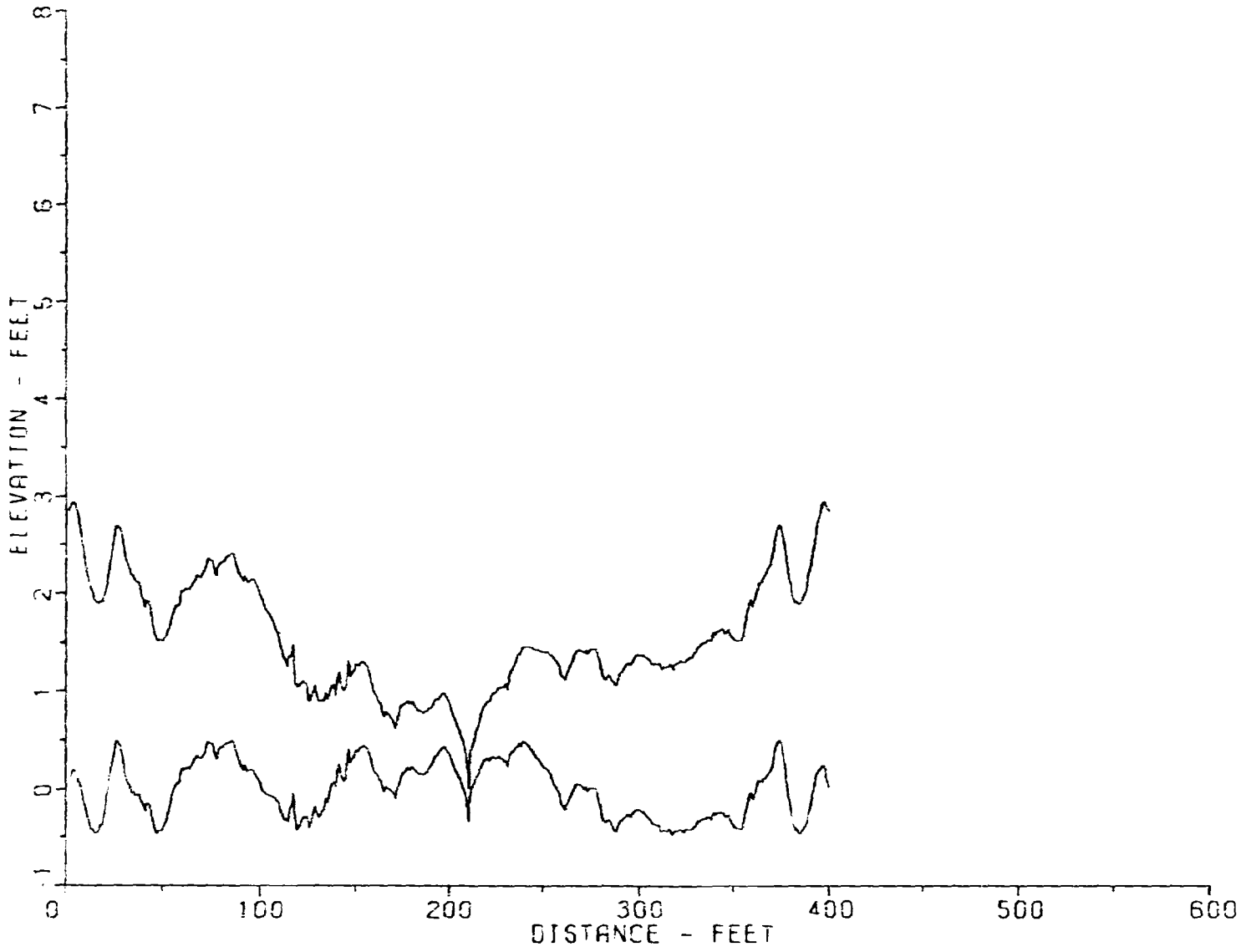
INTERVAL IN INCHES = 3

POINT	ELEVATIONS IN FEET									
1	.00	-.12	-.07	-.02	.08	.18	.27	.32	.34	.32
11	.27	.17	.03	-.19	-.03	.18	.33	.42	.48	.60
21	.48	.42	.33	.42	.47	.49	.47	.42	.32	.41
31	.47	.48	.47	.41	.32	.41	.46	.48	.46	.41
41	.31	.4[illegible]	.45	.47	.45	.40	.30	.39	.45	.47
51	.45	.3[illegible]	.30	.39	.44	.46	.44	.39	.29	.38
61	.43	.[illegible]5	.43	.38	.28	.37	.43	.45	.43	.37
71	.28	.37	.42	.44	.42	.37	.27	.36	.41	.43
81	.41	.36	.26	.35	.41	.43	.41	.35	.26	.35
91	.40	.42	.40	.35	.25	.34	.40	.41	.40	.34
101	.24	.33	.39	.41	.39	.33	.24	.33	.38	.40
111	.38	.33	.23	.32	.38	.39	.38	.32	.23	.31
121	.37	.39	.37	.31	.22	.31	.36	.38	.36	.31
131	.21	.30	.36	.37	.36	.30	.21	.30	.36	.37
141	.35	.34	.20	.29	.34	.36	.34	.29	.19	.28
151	.34	.35	.34	.28	.19	.28	.33	.36	.33	.28
161	.18	.27	.32	.34	.32	.27	.17	.26	.32	.34
171	.32	.26	.17	.26	.31	.33	.31	.26	.16	.25
181	.34	.32	.3[illegible]	.25	.16	.24	.30	.32	.30	.24
191	.15	.24	.29	.31	.29	.24	.14	.23	.29	.30
201	.29	.23	.13	.29	.28	.30	.28	.22	.13	.22
211	.27	.29	.27	.22	.12	.21	.27	.28	.27	.21
221	.11	.2[illegible]	.28	.28	.28	.20	.11	.20	.25	.27
231	.25	.2[illegible]	.1[illegible]	.19	.25	.26	.25	.19	.16	.18
241	.24	.26	.24	.18	.09	.18	.23	.25	.23	.18
251	.19	.24	.26	.24	.19	.09	-.01	-.07	.01	.10
261	.19	.27	.36	.41	.43	.41	.36	.33	.34	.33
271	.27	.17	.16	.21	.23	.21	.16	.06	.14	.19
281	.21	.1[illegible]	.14	.04	.11	.17	.19	.17	.11	.02
291	.09	.1[illegible]	.16	.14	.09	-.01	.07	.12	.14	.12
301	.07	-.[illegible]3	.04	.10	.12	.10	.04	-.05	.02	.08
311	.09	.0[illegible]	.02	-.07	-.[illegible]0	.05	.07	.05	-.00	-.10
321	-.02	.03	.05	.03	-.02	-.12	-.05	.01	.03	.01
331	-.05	-.14	-.17	-.07	.01	.10	.10	.27	.33	.34
341	.33	.27	.17	.03	-.18	-.03	.18	.32	.42	.47
351	.49	.47	.42	.32	.40	.45	.47	.45	.40	.30
361	.37	.4[illegible]	.44	.43	.37	.28	.35	.40	.42	.40
371	.35	.2[illegible]	.32	.36	.40	.38	.32	.23	.30	.36
381	.37	.36	.30	.20	.28	.33	.35	.33	.28	.18
391	.25	.31	.33	.31	.25	.16	.23	.20	.30	.28
401	.23	.13	.20	.26	.28	.26	.20	.11	.18	.24
411	.26	.24	.18	.19	.24	.26	.24	.19	.09	-.01
421	-.07	-.[illegible]2	.26	.00	.00	.00	.00	.00	-1.00	1.12

RMS = 1.709 INCHES

TABLE 4

RD03



RD04

Figure 10

6/21/78

TABLE 5

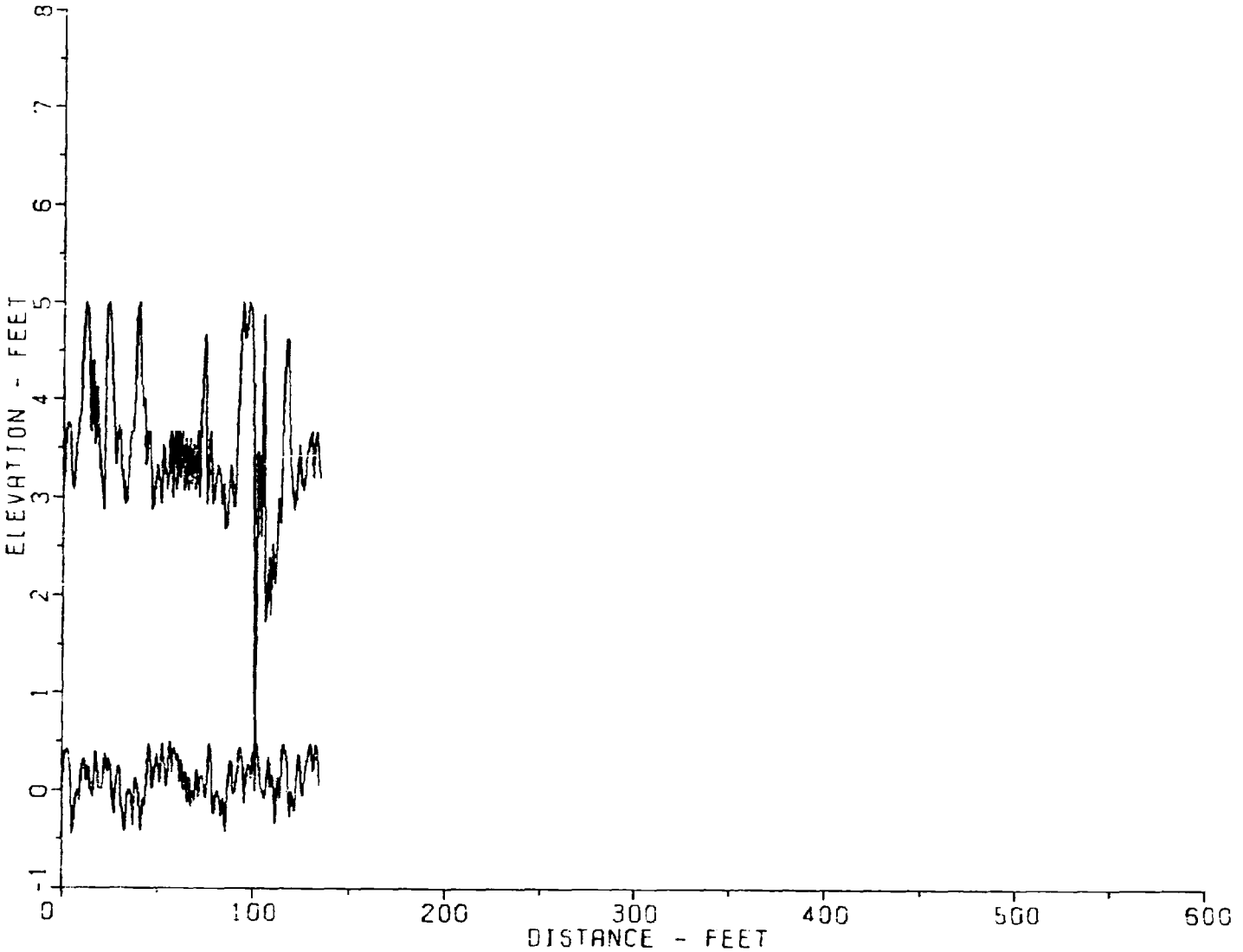
FORT KNOX MEDIUM 1964 ADDED TO THE DISK ON 1.MAR.77

NUMBER OF POINTS = 400

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.06	.16	.20	.18	.11	.06	-.03	-.12	-.21
11	-.29	-.38	-.41	-.42	-.45	-.46	-.44	-.38	-.36	-.28
21	-.15	.01	.12	.25	.38	.49	.49	.44	.36	.28
31	.12	.05	.00	-.05	-.05	-.08	-.07	-.06	-.14	-.18
41	-.24	-.15	-.18	-.26	-.34	-.43	-.47	-.44	-.43	-.42
51	-.37	-.31	-.24	-.15	-.07	.00	.07	.05	.09	.21
61	.19	.22	.21	.19	.23	.27	.30	.34	.31	.30
71	.34	.38	.46	.49	.46	.45	.35	.38	.39	.42
81	.42	.44	.46	.47	.48	.49	.48	.39	.33	.27
91	.22	.18	.24	.17	.18	.20	.18	.15	.11	.07
101	.00	-.03	-.04	-.06	-.07	-.08	-.08	-.10	-.13	-.15
111	-.21	-.25	-.32	-.31	-.34	-.22	-.18	-.05	-.31	-.43
121	-.39	-.34	-.29	-.29	-.29	-.41	-.38	-.28	-.18	-.25
131	-.29	-.27	-.23	-.20	-.10	-.14	-.03	.05	.07	.02
141	.16	.25	.13	.08	.11	.22	.41	.27	.30	.34
151	.40	.39	.42	.44	.45	.42	.41	.34	.29	.19
161	.16	.15	.09	.08	.01	-.03	.02	-.00	-.01	-.04
171	-.06	-.11	-.09	.06	.14	.17	.18	.21	.21	.20
181	.22	.19	.18	.15	.16	.16	.15	.17	.18	.22
191	.24	.26	.34	.34	.36	.40	.43	.43	.40	.37
201	.33	.29	.24	.18	.14	.09	.05	.01	-.07	-.15
211	-.34	-.08	.00	.06	.12	.18	.21	.23	.24	.30
221	.30	.28	.31	.32	.32	.31	.33	.31	.30	.28
231	.29	.23	.35	.37	.39	.42	.43	.46	.43	.48
241	.47	.45	.43	.40	.38	.34	.32	.30	.27	.24
251	.22	.20	.19	.14	.10	.06	.02	-.03	-.07	-.15
261	-.19	-.22	-.17	-.13	-.08	-.08	.01	.04	.04	.03
271	.02	-.01	.01	-.03	.00	.00	-.01	.00	-.05	-.18
281	-.25	-.34	-.36	-.34	-.33	-.38	-.41	-.45	-.48	-.37
291	-.33	-.32	-.30	-.28	-.26	-.30	-.26	-.23	-.21	-.22
301	-.22	-.24	-.23	-.27	-.30	-.32	-.36	-.37	-.37	-.38
311	-.37	-.44	-.43	-.44	-.45	-.42	-.43	-.48	-.44	-.43
321	-.44	-.43	-.45	-.46	-.43	-.43	-.43	-.42	-.39	-.38
331	-.34	-.35	-.33	-.31	-.32	-.30	-.30	-.32	-.25	-.28
341	-.25	-.25	-.24	-.25	-.29	-.29	-.27	-.33	-.37	-.48
351	-.42	-.42	-.42	-.43	-.37	-.27	-.18	-.07	-.05	-.12
361	-.05	.01	.08	.08	.07	.10	.10	.16	.18	.22
371	.30	.41	.47	.49	.48	.33	.18	.02	-.11	-.26
381	-.37	-.43	-.42	-.47	-.47	-.44	-.40	-.36	-.28	-.28
391	-.10	.00	.08	.16	.19	.24	.24	.19	.08	.08

RMS = 3.437 INCHES



R005

Figure 11

6/21/78

SY-, ROCK & LOG F.W.G. 1984 ADDED TO THE DISK ON 1.MAR.77

NUMBER OF POINTS = 270

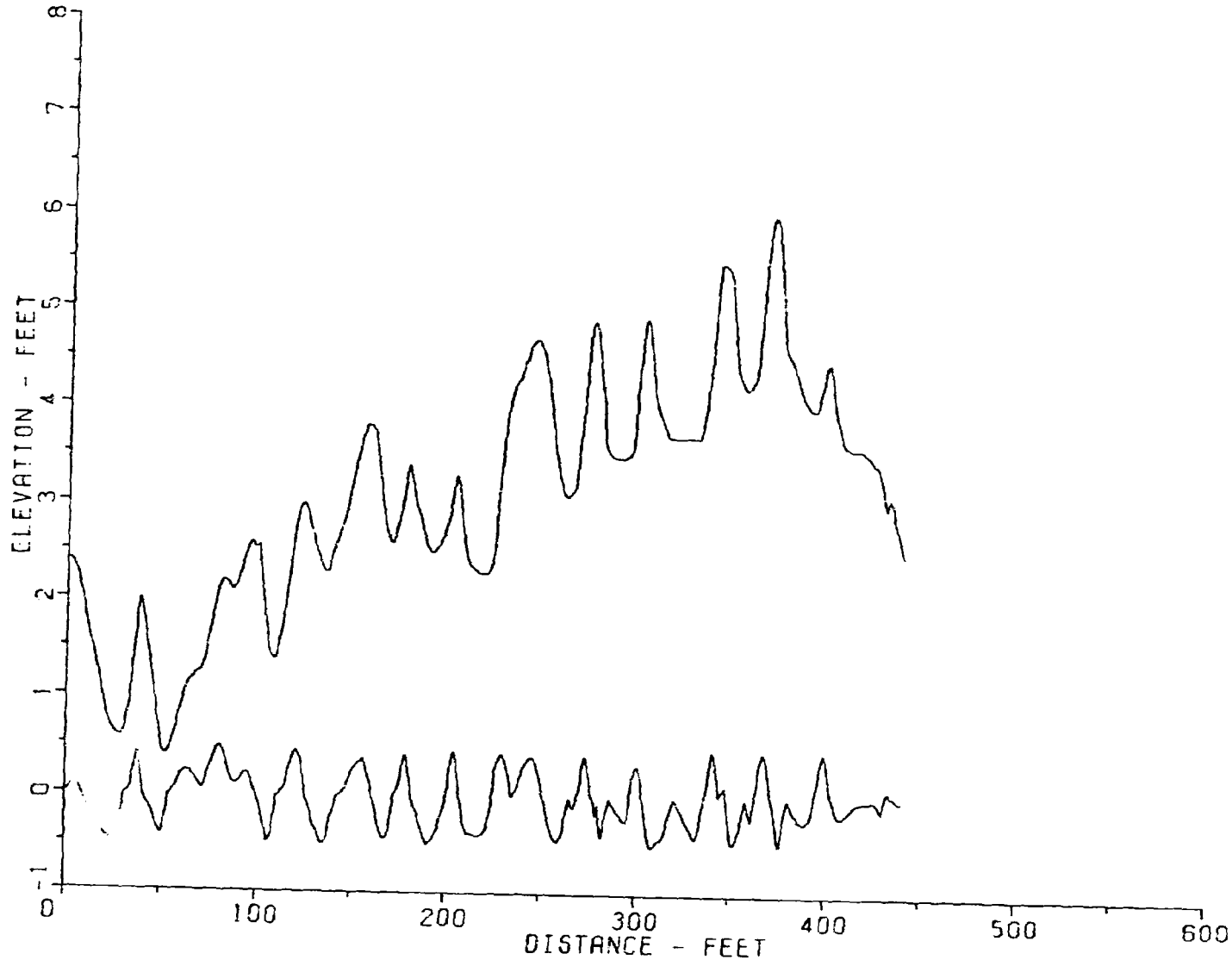
INTERVAL IN INCHES = 6

POINT	ELEVATIONS IN FEET									
1	.13	.33	.40	.41	.43	.38	.33	.24	.08	-.33
11	-.45	-.36	-.23	-.10	-.02	.00	-.05	-.11	-.02	.10
21	.27	.29	.33	.25	.09	.16	.25	.18	.05	-.03
31	.00	-.07	.08	.32	.48	.32	.14	.02	.03	.02
41	.01	.20	.13	.31	.38	.31	.19	.27	.33	.20
51	.14	.02	-.13	-.24	-.07	.11	.19	.23	.27	.28
61	.01	-.17	-.25	-.34	-.43	-.39	-.24	-.07	.08	.09
71	.01	-.07	-.23	-.36	-.18	.05	.13	.08	.01	-.07
81	-.27	-.42	-.33	-.16	-.08	-.15	-.13	.11	.26	.40
91	.47	.40	.19	.02	.06	.14	.22	.31	.37	.38
101	.19	.07	.17	.41	.48	.41	.30	.18	.03	.07
111	.25	.43	.59	.43	.19	.37	.44	.43	.35	.31
121	.38	.31	.06	.25	.32	.25	.01	.12	.19	.12
131	-.12	.04	.13	.06	-.16	-.07	.00	-.07	-.18	.14
141	.21	.14	-.07	.06	.13	.14	.15	.09	.02	-.07
151	-.07	.11	.26	.41	.49	.41	.17	-.21	-.23	-.15
161	-.08	-.04	.00	-.03	-.08	-.15	-.26	-.14	-.07	-.14
171	-.34	-.42	-.21	-.01	.12	.24	.31	.24	.04	-.04
181	.00	-.01	.03	.15	.26	.38	.45	.41	.37	.38
191	.08	-.13	.01	.19	.27	.26	.23	.16	.13	.32
201	.39	.32	.19	.41	.49	.41	.17	.11	.03	-.05
211	.40	-.07	-.07	.00	.10	.28	.35	.28	.04	.00
221	.16	.09	-.14	-.33	-.13	.07	.14	.07	-.07	.07
231	.24	.42	.48	.42	.40	.33	.13	-.07	-.27	-.07
241	.00	-.07	-.20	-.19	-.04	.11	.22	.32	.38	.31
251	.11	-.05	-.06	.04	.14	.24	.38	.38	.37	.44
261	.49	.42	.20	.27	.36	.43	.48	.48	.23	.04

RMS = 2.611 INCHES

TABLE 6

RDO5



R006

Figure 12

6/21/78

TABLE 7

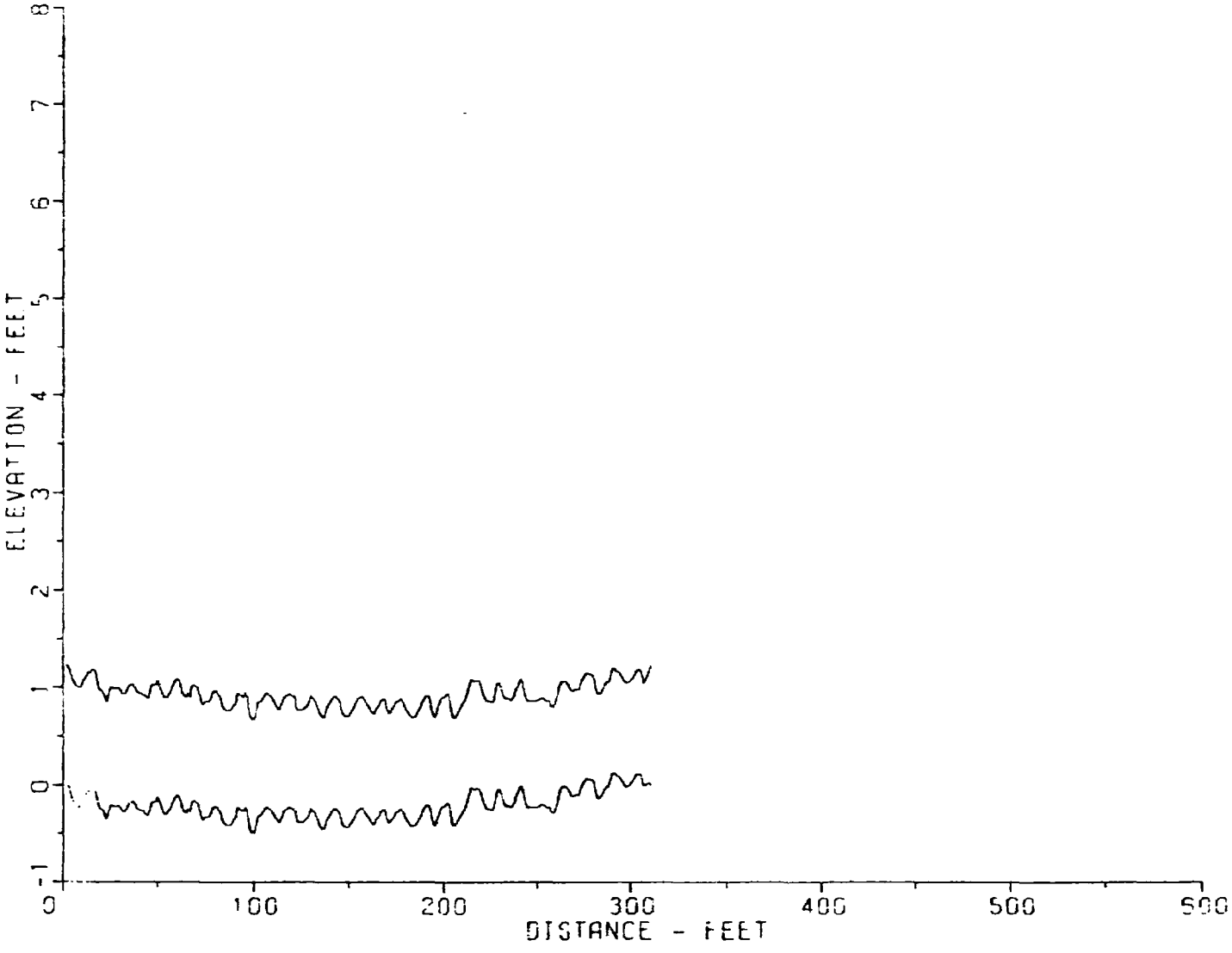
APG PERRYMAN III 1954 ADDED TO THE DISK ON 1-MAR-77

NUMBER OF POINTS = 440

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.04	.07	.08	.09	.06	.06	.02	-.03	-.08
11	-.13	-.16	-.17	-.20	-.23	-.25	-.29	-.33	-.39	-.42
21	-.45	-.46	-.47	-.46	-.43	-.38	-.34	-.28	-.20	-.10
31	.00	.01	.02	.09	.20	.28	.42	.41	.25	.04
41	-.04	-.08	-.12	-.17	-.20	-.25	-.30	-.36	-.41	-.42
51	-.35	-.25	-.12	-.00	.01	.04	.07	.11	.15	.20
61	.21	.23	.24	.23	.23	.18	.18	.15	.12	.08
71	.05	.09	.14	.20	.26	.33	.38	.43	.47	.49
81	.50	.45	.40	.33	.26	.18	.13	.11	.11	.13
91	.14	.16	.19	.22	.23	.21	.16	.07	.03	.00
101	-.07	-.15	-.22	-.31	-.40	-.48	-.45	-.38	-.28	-.14
111	.00	.01	.03	.06	.10	.14	.24	.33	.39	.44
121	.46	.48	.47	.29	.17	.02	-.07	-.14	-.20	-.27
131	-.34	-.39	-.44	-.47	-.49	-.48	-.46	-.36	-.27	-.19
141	-.13	-.06	.00	.00	.02	.04	.08	.13	.18	.22
151	.26	.30	.32	.35	.35	.38	.33	.28	.21	.12
161	.01	-.06	-.13	-.23	-.32	-.39	-.43	-.44	-.42	-.37
171	-.28	-.14	.02	.04	.10	.17	.29	.39	.43	.33
181	.17	.02	-.07	-.13	-.18	-.24	-.31	-.38	-.43	-.47
191	-.49	-.47	-.44	-.40	-.36	-.33	-.27	-.20	-.14	-.06
201	.05	.01	.37	.06	.41	.30	.13	-.04	-.19	-.29
211	-.36	-.38	-.39	-.40	-.39	-.40	-.40	-.39	-.38	-.37
221	-.34	-.30	-.24	-.13	.05	.24	.36	.41	.44	.43
231	.39	.31	.23	.13	.01	.02	.07	.12	.20	.22
241	.31	.35	.38	.40	.41	.41	.36	.30	.23	.13
251	.01	-.07	-.16	-.23	-.31	-.39	-.43	-.45	-.46	-.43
261	-.38	-.30	-.20	-.10	.00	-.10	-.11	-.06	.00	.07
271	.17	.25	.43	.36	.24	.05	.01	-.05	-.18	-.07
281	-.33	-.41	-.32	-.22	-.11	.00	-.04	-.08	-.11	-.14
291	-.17	-.19	-.21	-.24	-.25	-.19	.04	.23	.26	.33
301	.34	.22	.03	-.10	-.25	-.38	-.45	-.49	-.49	-.47
311	-.43	-.42	-.42	-.40	-.35	-.28	-.21	-.14	-.07	.00
321	-.04	-.07	-.11	-.15	-.19	-.22	-.26	-.30	-.34	-.37
331	-.41	-.44	-.33	-.24	-.12	.00	.07	.20	.35	.48
341	.46	.34	.19	.02	.06	.10	.12	-.04	-.18	-.38
351	-.48	-.45	-.41	-.36	-.30	-.21	-.11	.00	-.08	-.17
361	-.22	-.16	.03	.18	.34	.43	.47	.44	.36	.22
371	.03	-.04	-.12	-.27	-.42	-.48	-.34	-.22	-.11	.00
381	-.04	-.06	-.12	-.16	-.17	-.22	-.22	-.24	-.23	-.22
391	-.21	-.18	-.12	-.01	.11	.22	.34	.42	.48	.39
401	.25	.12	.03	-.04	-.10	-.16	-.18	-.18	-.17	-.16
411	-.15	-.12	-.10	-.06	-.05	-.03	-.02	-.01	-.01	-.01
421	-.02	-.01	-.02	-.01	-.00	.00	-.03	-.07	-.11	-.13
431	-.02	.09	.10	.05	.04	.03	.01	-.01	-.01	.00

RMS = 3.155 INCHES



R007

Figure 13

6/21/78

APPALACHIAN ELEC. 1964 ADDED TO THE DISK ON 18.APR.77

NUMBER OF POINTS = 311

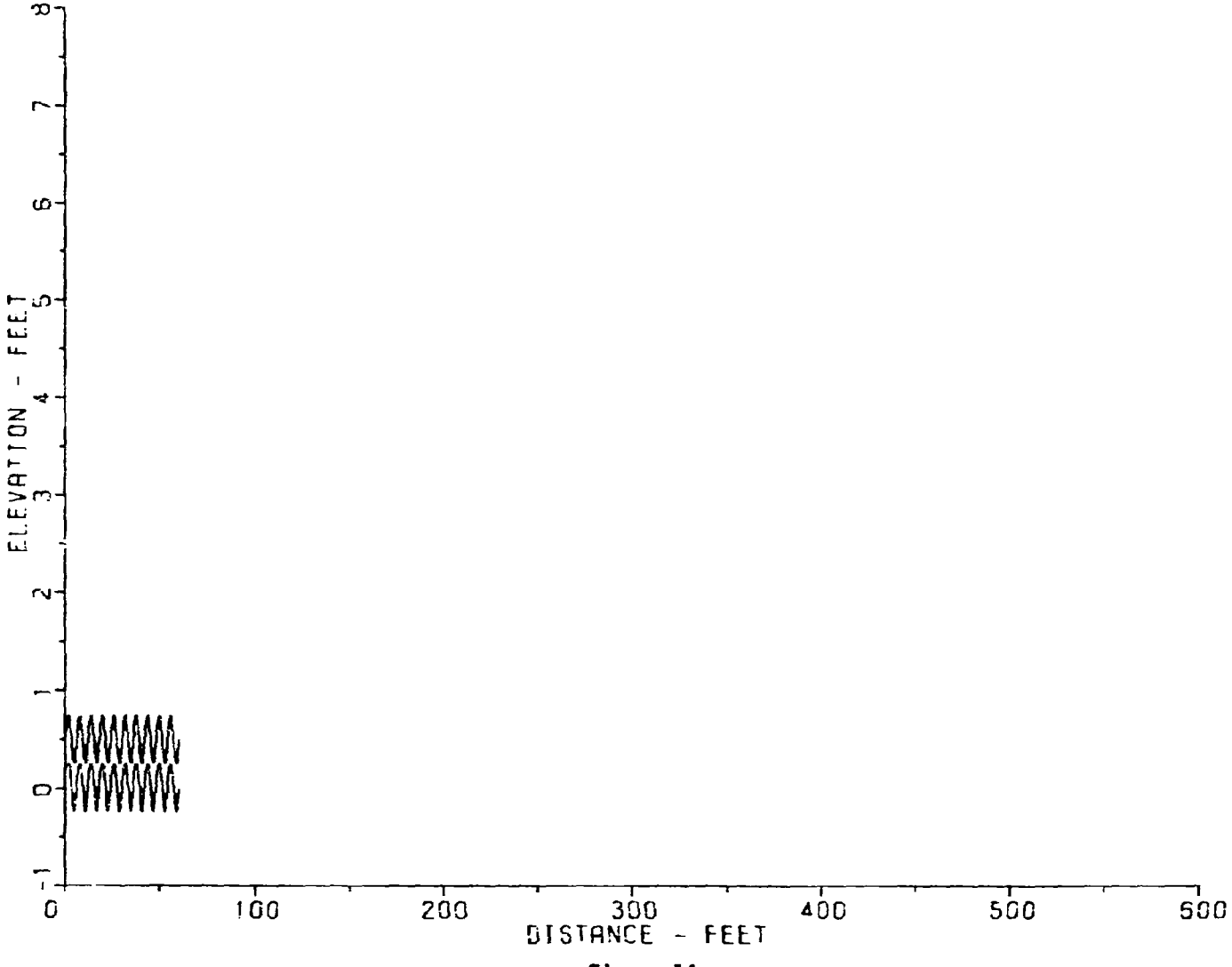
INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.00	-.03	-.09	-.15	-.19	-.21	-.22	-.21	-.17
11	-.12	-.08	-.06	-.05	-.03	-.03	-.04	-.14	-.03	-.24
21	-.26	-.32	-.35	-.26	-.20	-.21	-.22	-.21	-.21	-.23
31	-.26	-.27	-.25	-.21	-.17	-.16	-.16	-.20	-.24	-.26
41	-.26	-.27	-.29	-.31	-.30	-.23	-.17	-.17	-.15	-.12
51	-.15	-.25	-.29	-.29	-.29	-.25	-.22	-.17	-.12	-.10
61	-.11	-.17	-.24	-.28	-.29	-.25	-.27	-.16	-.15	-.17
71	-.18	-.27	-.34	-.36	-.32	-.32	-.32	-.28	-.22	-.21
81	-.22	-.26	-.29	-.35	-.39	-.42	-.42	-.40	-.38	-.35
91	-.32	-.22	-.24	-.26	-.27	-.22	-.29	-.40	-.48	-.58
101	-.45	-.36	-.31	-.30	-.26	-.23	-.21	-.23	-.25	-.28
111	-.30	-.35	-.38	-.39	-.32	-.26	-.24	-.23	-.22	-.24
121	-.26	-.24	-.37	-.38	-.38	-.37	-.36	-.34	-.30	-.23
131	-.28	-.28	-.32	-.38	-.42	-.45	-.45	-.39	-.33	-.29
141	-.26	-.24	-.23	-.25	-.28	-.34	-.41	-.43	-.42	-.42
151	-.39	-.36	-.32	-.28	-.24	-.23	-.22	-.26	-.29	-.32
161	-.35	-.39	-.40	-.37	-.33	-.31	-.26	-.24	-.25	-.33
171	-.39	-.38	-.34	-.31	-.27	-.26	-.24	-.26	-.29	-.33
181	-.37	-.40	-.42	-.42	-.40	-.38	-.34	-.31	-.26	-.22
191	-.20	-.20	-.25	-.34	-.41	-.39	-.32	-.27	-.22	-.21
201	-.20	-.18	-.17	-.30	-.41	-.41	-.39	-.36	-.31	-.28
211	-.24	-.22	-.15	-.08	-.02	-.04	-.04	-.03	-.04	-.08
221	-.14	-.20	-.23	-.23	-.24	-.25	-.22	-.13	-.05	-.04
231	-.08	-.15	-.21	-.21	-.21	-.23	-.22	-.17	-.11	-.07
241	-.03	-.07	-.06	-.15	-.22	-.22	-.22	-.22	-.22	-.22
251	-.21	-.22	-.19	-.21	-.22	-.22	-.22	-.27	-.28	-.25
261	-.19	-.12	-.04	-.01	-.00	-.01	-.04	-.07	-.11	-.11
271	-.09	-.08	-.09	-.04	.01	.05	.07	.07	.06	.07
281	.03	-.04	-.13	-.13	-.11	-.07	-.03	-.01	-.01	.06
291	.13	.13	.10	.09	.08	.04	-.00	-.02	-.00	.02
301	.04	.07	.10	.12	.13	.09	-.00	.00	.02	.02
311	.00	-1.00	1.12	.00	.20	-.55	-.41	-.27	-.13	.00

RMS = 1.639 INCHES

TABLE 8

RD07



R008

Figure 14

6/21/78

SIX INCH SINE WAVE COURSE 1964 ADDED TO THE DISK ON 3.MAR.77

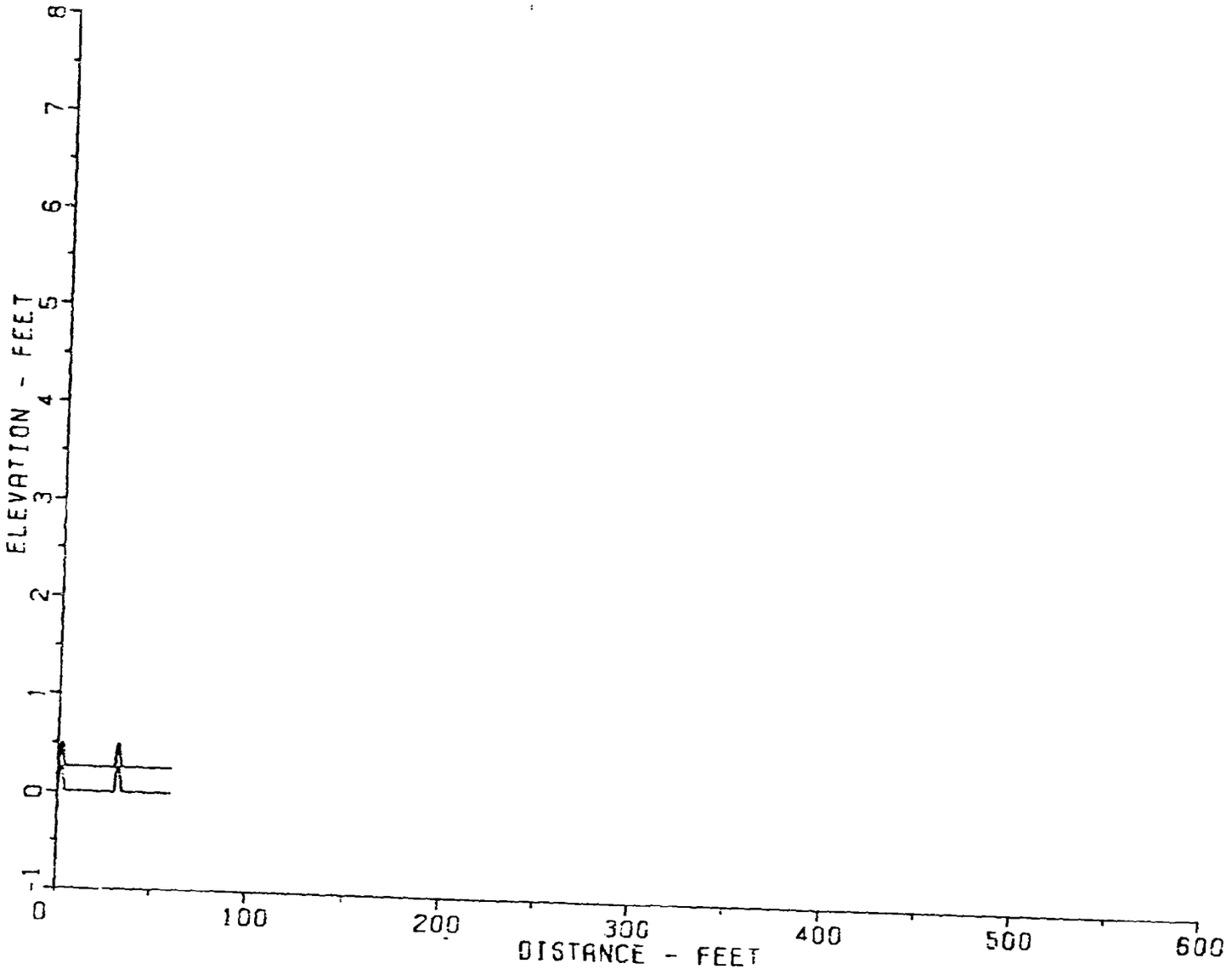
NUMBER OF POINTS = 241

INTERVAL IN INCHES = 3

POINT	ELEVATIONS IN FEET									
1	.00	.11	.16	.20	.23	.24	.20	.24	.23	.20
11	.16	.11	.06	-.01	-.07	-.13	-.20	-.23	-.05	-.23
21	-.20	-.13	-.07	-.01	.06	.11	.16	.20	.23	.24
31	.25	.24	.23	.20	.16	.11	.06	-.01	-.07	-.13
41	-.19	-.23	-.25	-.23	-.20	-.13	-.07	-.01	.05	.11
51	.16	.20	.23	.24	.25	.24	.23	.20	.16	.11
61	.05	-.01	-.07	-.13	-.20	-.23	-.25	-.23	-.20	-.13
71	-.07	-.01	.06	.11	.16	.20	.23	.24	.25	.24
81	.23	.20	.16	.11	.06	-.01	-.07	-.13	-.19	-.23
91	-.25	-.23	-.19	-.13	-.07	-.01	.05	.11	.16	.20
101	.23	.24	.25	.24	.23	.20	.16	.11	.06	-.01
111	-.07	-.13	-.19	-.23	-.25	-.23	-.20	-.13	-.07	-.01
121	.06	.11	.16	.20	.23	.24	.25	.24	.23	.20
131	.16	.11	.05	-.01	-.07	-.13	-.19	-.23	-.25	-.23
141	-.19	-.13	-.07	-.01	.06	.11	.16	.20	.23	.24
151	.25	.24	.23	.20	.16	.11	.06	-.01	-.07	-.13
161	-.20	-.23	-.25	-.23	-.19	-.13	-.07	-.01	.05	.11
171	.16	.20	.23	.24	.25	.24	.23	.20	.16	.11
181	.05	-.01	-.07	-.13	-.19	-.23	-.25	-.23	-.19	-.13
191	-.07	-.01	.06	.11	.16	.20	.23	.24	.25	.24
201	.23	.20	.16	.11	.05	-.01	-.07	-.13	-.20	-.23
211	-.25	-.23	-.20	-.13	-.07	-.01	.06	.11	.16	.20
221	.23	.24	.25	.24	.23	.20	.16	.11	.06	-.01
231	-.07	-.13	-.20	-.23	-.25	-.23	-.20	-.13	-.07	-.02
241	.00	-1.00	1.12	-.24	-.22	-.18	-.13	-.00	.00	.00

RMS = 2.069 INCHES

TABLE 9



R009

Figure 15

6/21/78

THREE INCH SPACED BUMP 1964 ADDED TO THE DISK ON 3-MAR-77

NUMBER OF POINTS = 241

INTERVAL IN INCHES = 3

POINT	ELEVATIONS IN FEET									
1	.07	.12	.17	.20	.23	.24	.25	.24	.[illegible]	.[illegible]
11	.17	.12	.07	.01	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
21	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
31	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
41	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
51	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
61	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
71	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
81	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
91	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
101	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
111	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.21
121	.07	.12	.17	.20	.23	.24	.25	.24	.23	.[illegible]
131	.17	.12	.07	.01	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
141	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
151	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
161	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
171	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
181	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
191	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
201	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
211	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
221	.20	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
231	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
241	.01	-1.00	1.12	.00	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]

RMS = .7065 INCHES

TABLE 10

RD09

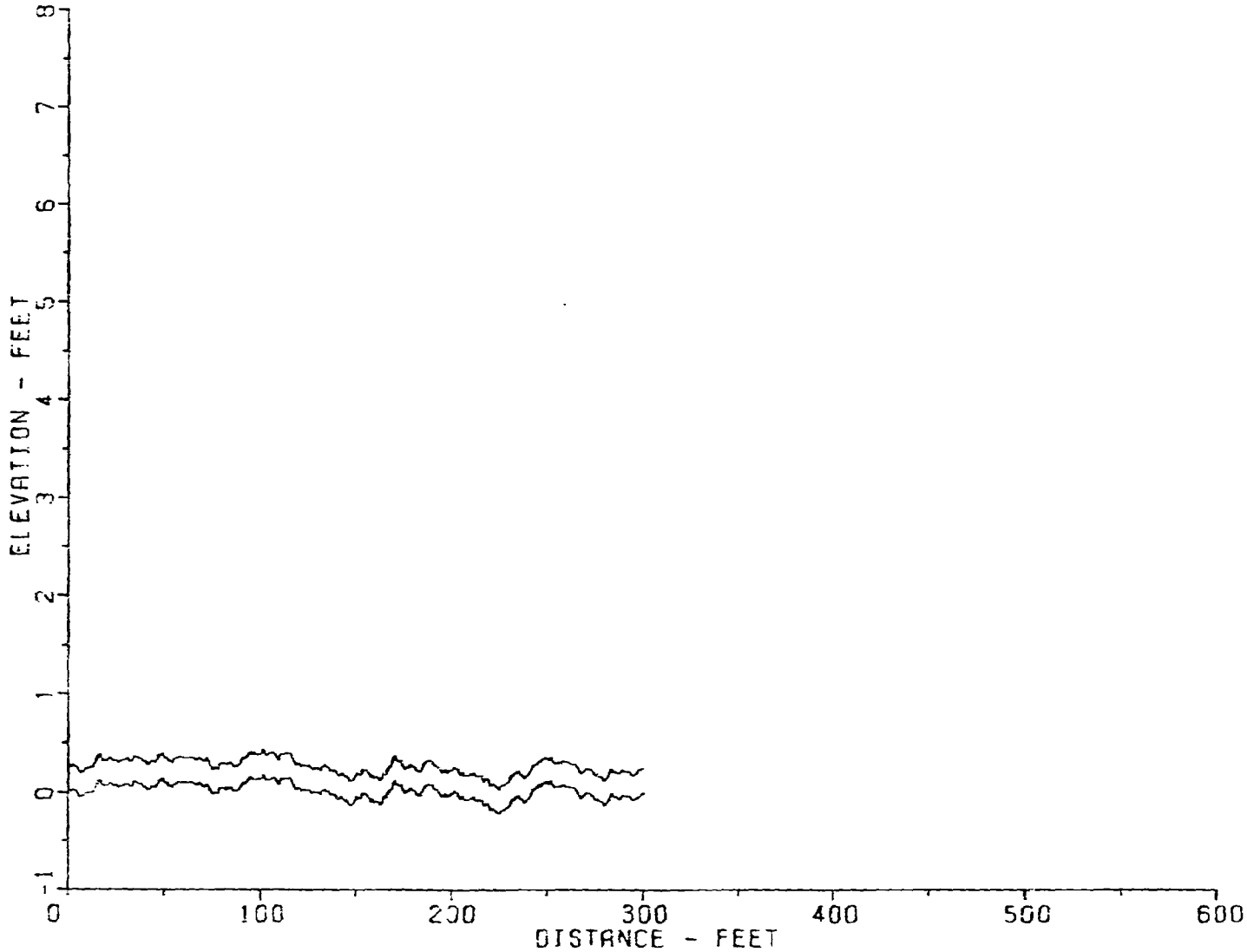


Figure 16

RD10

6/21/78

R010

RMS=1 ADDED TO THE DISK ON 11.MAR.77

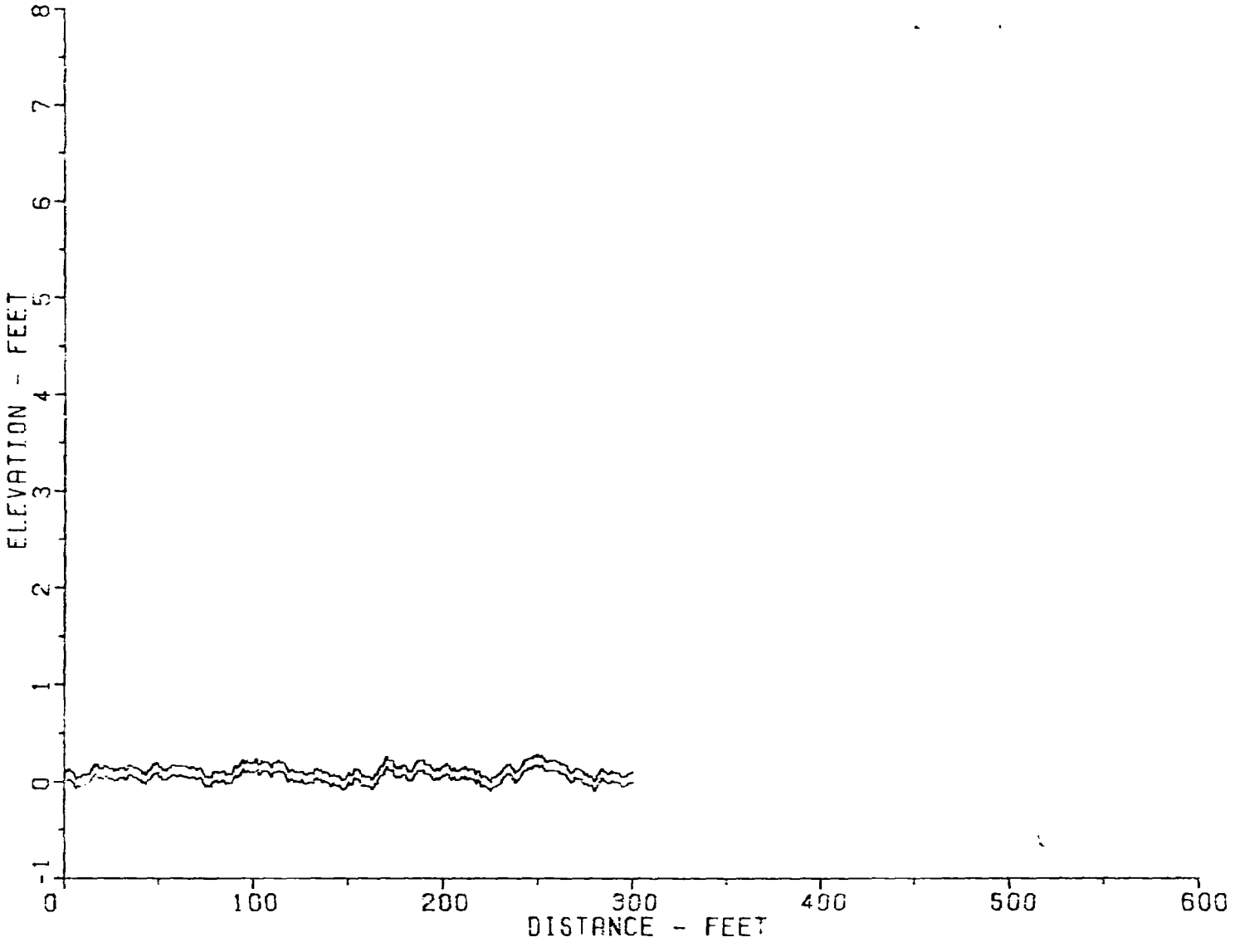
NUMBER OF POINTS = 300

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.03	.01	.01	-.01	-.00	-.04	-.04	-.01	-.01
11	.00	.00	.01	.05	.09	.12	.12	.06	.08	.07
21	.09	.10	.07	.07	.07	.05	.07	.06	.06	.09
31	.09	.06	.07	.11	.11	.09	.09	.08	.06	.06
41	.03	.03	.06	.06	.05	.08	.12	.13	.14	.09
51	.10	.06	.07	.05	.09	.09	.11	.11	.10	.10
61	.11	.10	.10	.10	.09	.08	.08	.10	.08	.06
71	.06	.09	.06	.02	-.01	.00	-.01	-.02	.04	.05
81	.05	.03	.03	.05	.05	.01	.02	.02	.03	.05
91	.10	.09	.11	.14	.16	.13	.15	.13	.14	.14
101	.15	.18	.12	.13	.15	.15	.15	.13	.11	.08
111	.14	.14	.14	.15	.14	.15	.12	.06	.03	.04
121	.05	.02	.03	.02	.02	.03	.00	-.01	-.01	.00
131	-.01	-.03	.02	.03	.00	.01	-.03	-.02	-.03	-.03
141	-.07	-.07	-.05	-.08	-.09	-.08	-.13	-.13	-.12	-.08
151	-.05	-.07	-.06	-.01	-.02	-.03	-.06	-.09	-.07	-.10
161	-.09	-.10	-.13	-.09	-.05	-.06	-.01	.02	.02	.09
171	.12	.07	.07	.06	.02	-.01	.01	.00	.04	.02
181	.01	-.03	-.04	-.03	.01	.04	.07	.07	.07	.07
191	.03	.02	.01	.00	-.04	-.05	-.02	-.06	-.03	-.02
201	.00	.01	-.01	-.06	-.07	-.04	-.08	-.08	-.07	-.06
211	-.07	-.05	-.09	-.08	-.09	-.08	-.15	-.12	-.11	-.18
221	-.17	-.18	-.19	-.21	-.23	-.19	-.18	-.17	-.16	-.15
231	-.11	-.08	-.06	-.04	-.03	-.07	-.08	-.11	-.09	-.07
241	-.04	-.01	.03	.03	.05	.07	.06	.09	.09	.10
251	.08	.11	.07	.05	.05	.06	.05	.07	.07	.06
261	.06	.04	.04	.04	.02	.00	-.04	-.06	-.04	-.01
271	-.01	-.01	-.03	-.04	-.07	-.07	-.09	-.10	-.10	-.14
281	-.11	-.08	-.05	-.01	-.05	-.04	-.06	-.06	-.03	-.04
291	-.04	-.04	-.04	-.07	-.08	-.07	-.05	-.03	-.02	.00

RMS = .9727 INCHES

TABLE 11



RD12

Figure 17

6/22/78

RC [illegible] RMS APRIL 77 ADDED TO THE LIBR ON 11-MAR-77

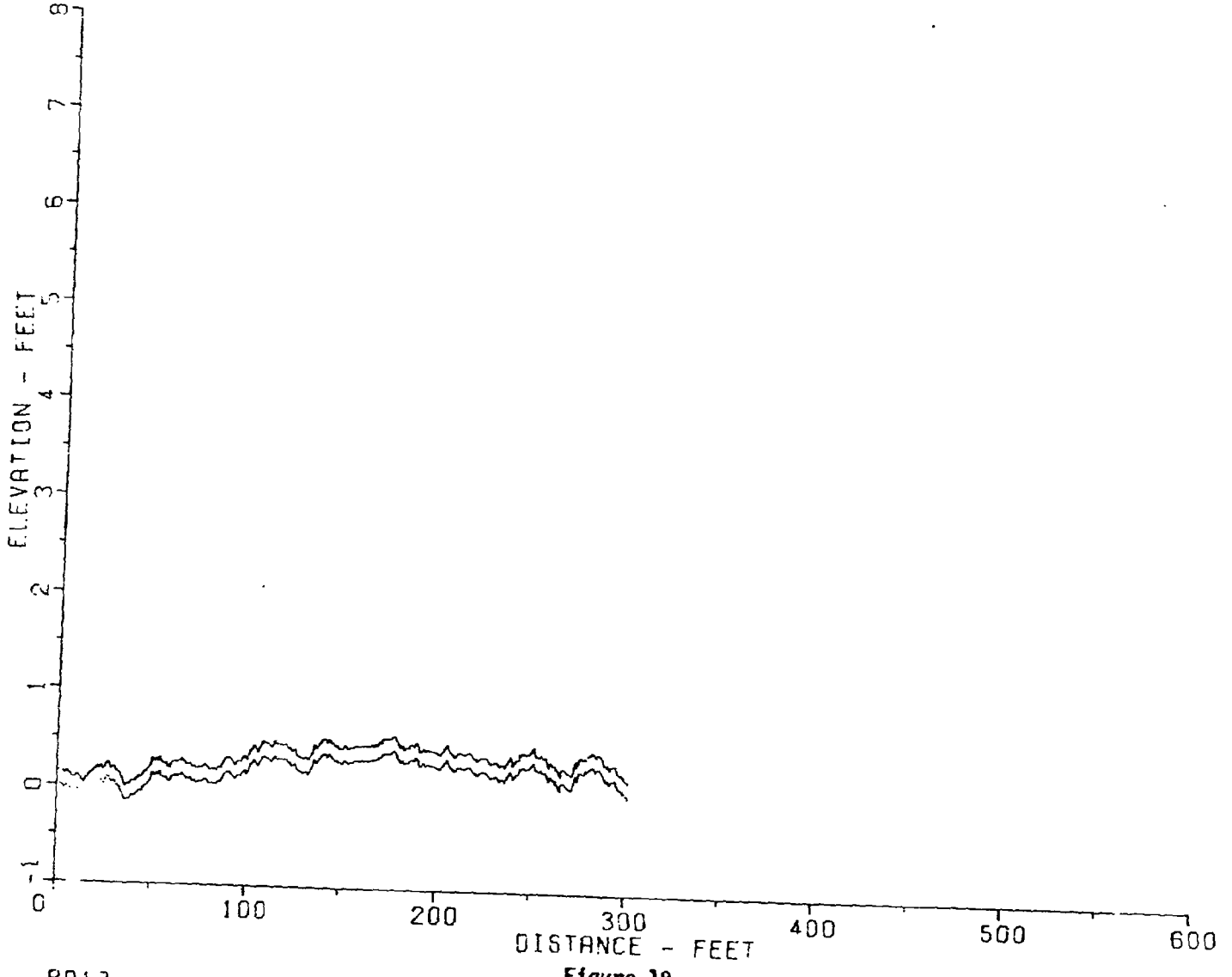
NUMBER OF POINTS = 300

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.03	.01	.00	-.02	-.07	-.05	-.06	-.03	-.03
11	-.03	-.02	-.02	.02	.05	.08	.06	.03	.04	.03
21	.06	.06	.04	.03	.04	.01	.03	.02	.04	.05
31	.05	.02	.03	.07	.07	.06	.05	.04	.03	.03
41	-.01	.00	-.03	.02	.02	.05	.08	.00	.10	.03
51	.06	.02	.03	.01	.05	.05	.07	.07	.06	.06
61	.07	.07	.06	.06	.05	.04	.04	.06	.04	.02
71	.03	.05	.02	-.02	-.05	-.04	-.05	-.06	.00	.01
81	.01	-.01	.00	.01	.01	-.03	-.01	-.02	-.01	.02
91	.07	.05	.07	.10	.13	.09	.12	.10	.10	.10
101	.11	.14	.08	.09	.12	.11	.11	.10	.08	.05
111	.10	.10	.11	.12	.10	.11	.09	.03	.08	.02
121	.03	.00	.01	.00	.00	.02	-.01	-.02	-.01	.00
131	-.01	-.02	.03	.04	.02	.03	-.01	.01	.00	-.01
141	-.04	-.03	-.01	-.00	-.05	-.03	-.06	-.08	-.07	-.03
151	.00	-.03	-.02	.04	.03	.02	-.01	-.05	-.03	-.05
161	-.04	-.05	-.08	-.05	-.01	-.02	.03	.07	.06	.13
171	.10	.12	.12	.13	.06	.04	.06	.04	.08	.07
181	.06	.01	.01	.01	.06	.09	.12	.12	.12	.12
191	.08	.09	.07	.05	.02	.02	.04	.02	.04	.06
201	.07	.04	.07	.03	.02	.05	.01	.00	.03	.05
211	.03	.06	.02	.04	.03	.03	-.03	.01	.01	-.00
221	-.04	-.05	-.06	-.08	-.10	-.06	-.05	-.04	-.03	-.02
231	.01	.05	.06	.08	.09	.04	.03	-.01	.01	.03
241	.06	.09	.12	.12	.14	.15	.14	.17	.16	.18
251	.15	.18	.14	.11	.11	.12	.11	.12	.12	.11
261	.11	.08	.09	.08	.07	.04	.01	-.01	.00	.04
271	.03	.03	.02	.00	-.03	-.02	-.05	-.06	-.06	-.10
281	-.07	-.03	.00	.04	.00	.00	-.02	-.02	.01	-.01
291	-.01	-.01	-.02	-.05	-.06	-.05	-.04	-.02	-.01	.00

RMS = .6787 INCHES

TABLE 12



RD13

Figure 18

6/22/78

APS TERRAIN [illegible] ADDED TO THE DISK ON 11.MAR.77

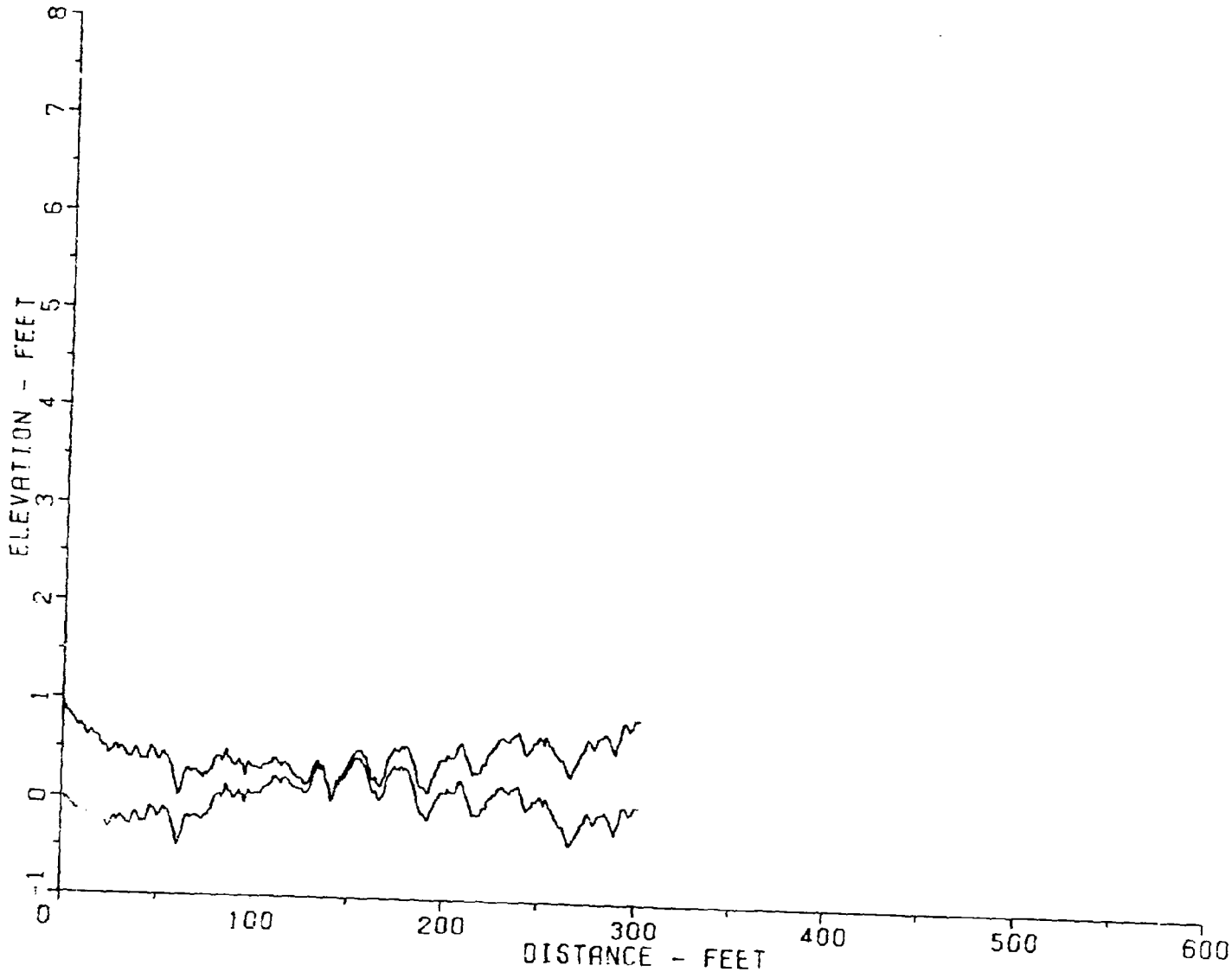
NUMBER OF POINTS = 301

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	[illegible]	-.02	-.03	-.01	-.03	-.04	-.07	-.06	-.05
11	-.04	-.06	-.10	-.12	-.07	-.06	-.03	-.02	.00	.02
21	.05	.03	.06	.01	.06	.09	.09	.03	.05	.04
31	.02	-.01	-.02	-.07	-.13	-.15	-.12	-.13	-.09	-.10
41	-.09	-.07	-.05	-.04	-.04	.01	.01	.05	.08	.15
51	.12	.15	.12	.16	.10	.09	.10	.06	.05	.11
61	.12	.13	.11	.13	.12	.15	.10	.09	.10	.11
71	.07	.08	.06	.05	.07	.07	.09	.10	.08	.05
81	.06	.04	.04	.04	.08	.06	.10	.15	.17	.17
91	.17	.15	.12	.10	.14	.15	.13	.17	.19	.15
101	.19	.25	.27	.31	.26	.24	.29	.32	.34	.33
111	.33	.31	.29	.31	.35	.33	.32	.31	.32	.33
121	.32	.29	.29	.25	.26	.28	.21	.20	.19	.18
131	.20	.19	.17	.22	.24	.33	.29	.31	.35	.38
141	.39	.38	.35	.39	.34	.35	.31	.33	.29	.30
151	.29	.33	.30	.29	.31	.30	.32	.32	.32	.32
161	.32	.33	.33	.33	.32	.34	.32	.35	.33	.37
171	.36	.40	.42	.41	.40	.41	.43	.43	.40	.35
181	.32	.34	.30	.32	.32	.35	.35	.33	.37	.34
191	.28	.29	.32	.29	.31	.30	.29	.29	.28	.27
201	.25	.26	.30	.33	.36	.32	.29	.27	.24	.25
211	.29	.28	.27	.26	.27	.28	.29	.27	.24	.23
221	.20	.22	.24	.24	.24	.24	.20	.18	.19	.18
231	.22	.18	.15	.17	.16	.13	.20	.23	.25	.17
241	.20	.22	.23	.28	.30	.30	.28	.28	.30	.31
251	.36	.28	.27	.27	.28	.24	.26	.28	.25	.21
261	.18	.18	.13	.12	.07	.14	.13	.12	.10	.09
271	.07	.12	.22	.17	.26	.26	.24	.25	.28	.29
281	.30	.31	.30	.27	.30	.29	.27	.20	.18	.19
291	.14	.18	.17	.19	.14	.09	.10	.07	.03	.02
301	.00	-1.00	1.12	.00	.00	.00	.00	.00	.00	.00

RMS = 1.594 INCHES

TABLE 13



RD14

Figure 19

5/22/78

RD14

APG TERRAIN 9 RMS=1.77 ADDED TO THE DISK ON 11.MAR.77

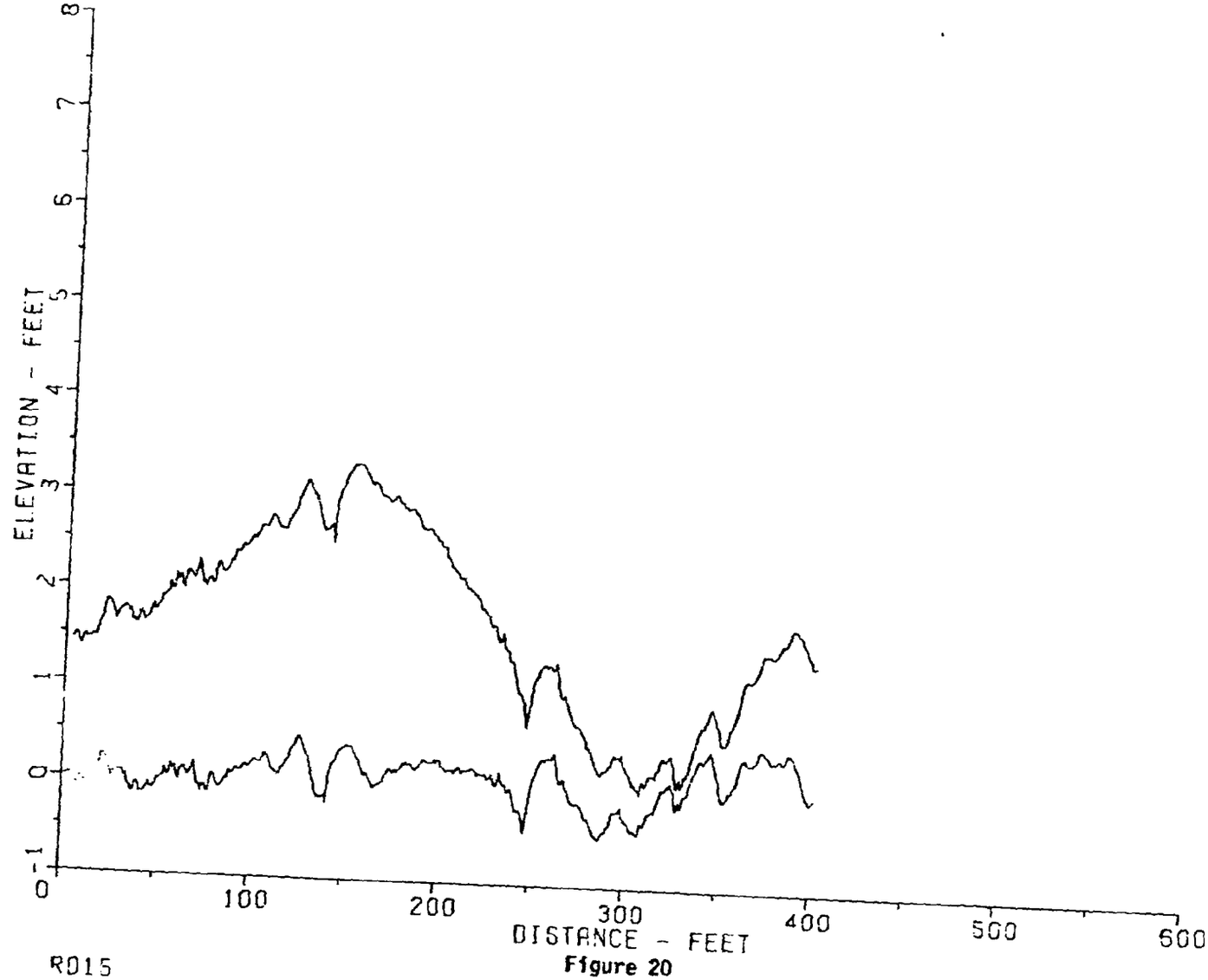
NUMBER OF POINTS = 301

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.03	-.03	-.05	-.07	-.10	-.13	-.14	-.11	-.14
11	-.15	-.18	-.20	-.16	-.14	-.17	-.18	-.18	-.18	-.24
21	-.28	-.24	-.26	-.31	-.29	-.26	-.21	-.21	-.25	-.28
31	-.26	-.22	-.24	-.27	-.27	-.26	-.22	-.18	-.18	-.21
41	-.26	-.25	-.24	-.25	-.17	-.09	-.10	-.13	-.17	-.20
51	-.16	-.12	-.11	-.14	-.13	-.17	-.22	-.27	-.36	-.44
61	-.49	-.42	-.34	-.26	-.20	-.18	-.21	-.19	-.17	-.18
71	-.19	-.20	-.22	-.22	-.17	-.19	-.14	-.11	-.07	.01
81	.04	.05	.05	.02	.07	.15	.07	.00	.05	.01
91	.03	.07	.09	.04	.04	-.04	.07	.09	.06	.06
101	.07	.06	.06	.07	.11	.13	.14	.15	.16	.17
111	.23	.24	.22	.21	.17	.22	.24	.21	.20	.17
121	.13	.14	.12	.12	.13	.11	.09	.09	.11	.14
131	.20	.26	.32	.36	.32	.32	.31	.22	.17	.09
141	.01	.03	.11	.19	.18	.22	.22	.25	.29	.33
151	.35	.39	.44	.45	.44	.44	.40	.37	.37	.26
161	.21	.13	.10	.12	.06	.02	.03	.08	.13	.01
171	.28	.30	.34	.36	.34	.32	.37	.37	.34	.36
181	.34	.27	.24	.18	.10	.00	-.08	-.10	-.11	-.14
191	-.17	-.16	-.08	-.06	-.01	.04	.07	.11	.11	.11
201	.11	.16	.12	.12	.11	.14	.17	.22	.24	.18
211	.11	.08	.04	-.04	-.11	-.18	-.12	-.11	-.11	-.04
221	-.04	-.04	.05	.07	.09	.11	.10	.16	.17	.17
231	.18	.15	.13	.12	.16	.17	.18	.18	.20	.13
241	.07	-.00	-.06	-.04	-.01	.00	.04	.04	.06	.10
251	.06	.00	.07	.03	-.03	-.04	-.08	-.13	-.15	-.16
261	-.20	-.21	-.27	-.32	-.38	-.41	-.37	-.33	-.30	-.26
271	-.22	-.18	-.18	-.11	-.07	-.10	-.14	-.18	-.18	-.20
281	-.08	-.08	-.07	-.05	-.09	-.14	-.19	-.24	-.26	-.26
291	-.15	-.04	-.00	-.00	-.03	-.09	-.07	-.06	.00	-.00
301	.00	-1.00	1.12	.00	-.03	.00	.00	.00	.00	.00

RMS = 2.323 INCHES

TABLE 14



R015

Figure 20

6/22/78

APG TERRAIN 11 RMS = 1.32 1974 ADDED TO THE DISK ON 18.APR.77

NUMBER OF POINTS = 421

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.01	.02	.01	.00	.04	-.04	-.09	-.01	-.08
11	-.05	-.05	-.06	-.04	-.08	-.07	-.08	.05	.08	-.15
21	.25	.24	.22	.17	.09	.00	.04	.06	.08	.07
31	.08	.06	.01	.03	-.08	-.10	-.14	-.13	-.05	-.06
41	-.15	-.14	-.15	-.10	-.09	-.04	-.10	-.10	-.06	-.08
51	.01	.01	.02	.03	.11	.03	.06	.17	.11	.14
61	.04	-.01	.11	.13	.13	.09	.04	.07	.11	.10
71	.10	-.04	-.06	-.11	-.05	-.08	-.11	-.11	-.01	.07
81	.04	-.03	-.06	-.06	-.04	-.01	.02	.08	.11	.08
91	.09	.11	.15	.12	.11	.14	.18	.19	.16	.14
101	.20	.23	.24	.22	.20	.23	.26	.30	.27	.23
111	.19	.13	.12	.10	.08	.09	.16	.17	.20	.24
121	.29	.34	.38	.42	.46	.49	.49	.41	.36	.32
131	.27	.19	.10	.01	-.07	-.13	-.12	-.14	-.12	-.10
141	-.19	.06	.15	.23	.24	.28	.33	.35	.36	.39
151	.41	.39	.40	.39	.37	.33	.28	.24	.20	.14
161	.10	.13	.10	.04	.00	-.03	.01	.01	.03	.04
171	.04	.09	.14	.17	.17	.14	.18	.14	.17	.17
181	.20	.24	.26	.23	.24	.24	.18	.18	.20	.22
191	.25	.27	.28	.26	.26	.26	.26	.25	.23	.20
201	.20	.21	.21	.19	.17	.18	.18	.18	.16	.15
211	.22	.21	.15	.16	.18	.19	.19	.21	.19	.19
221	.13	.16	.16	.14	.17	.13	.10	.13	.16	.06
231	.04	.07	.10	.08	.04	.06	-.01	-.00	.02	-.03
241	-.16	-.22	-.22	-.20	-.26	-.34	-.44	-.26	-.09	.01
251	.12	.16	.22	.28	.31	.33	.30	.34	.04	-.08
261	.33	.40	.31	.16	.08	.10	.14	.05	.02	-.06
271	-.10	-.12	-.14	-.12	-.13	-.16	-.17	-.22	-.23	-.27
281	-.31	-.36	-.40	-.45	-.46	-.49	-.48	-.44	-.41	-.41
291	-.35	-.33	-.26	-.19	-.20	-.19	-.21	-.14	-.25	-.29
301	-.30	-.31	-.35	-.40	-.38	-.41	-.41	-.43	-.30	-.33
311	-.32	-.25	-.21	-.20	-.19	-.19	-.11	-.08	-.01	.05
321	.05	.05	.09	.13	.08	.05	-.06	-.16	-.06	-.14
331	-.08	-.00	.00	.05	.11	.18	.23	.08	.05	.31
341	.37	.34	.37	.41	.46	.47	.39	.30	.22	.18
351	.02	-.03	-.06	-.04	-.00	.05	.05	.09	.13	.17
361	.26	.33	.40	.41	.37	.34	.33	.34	.36	.37
371	.40	.47	.49	.47	.45	.44	.42	.39	.37	.36
381	.38	.40	.40	.37	.37	.40	.48	.47	.44	.42
391	.36	.31	.27	.20	.14	.06	.03	-.01	-.03	-.03
401	.00	-1.00	1.12	.00	.01	.00	.00	.00	.00	.00

RMS = 2.653 INCHES

TABLE 15

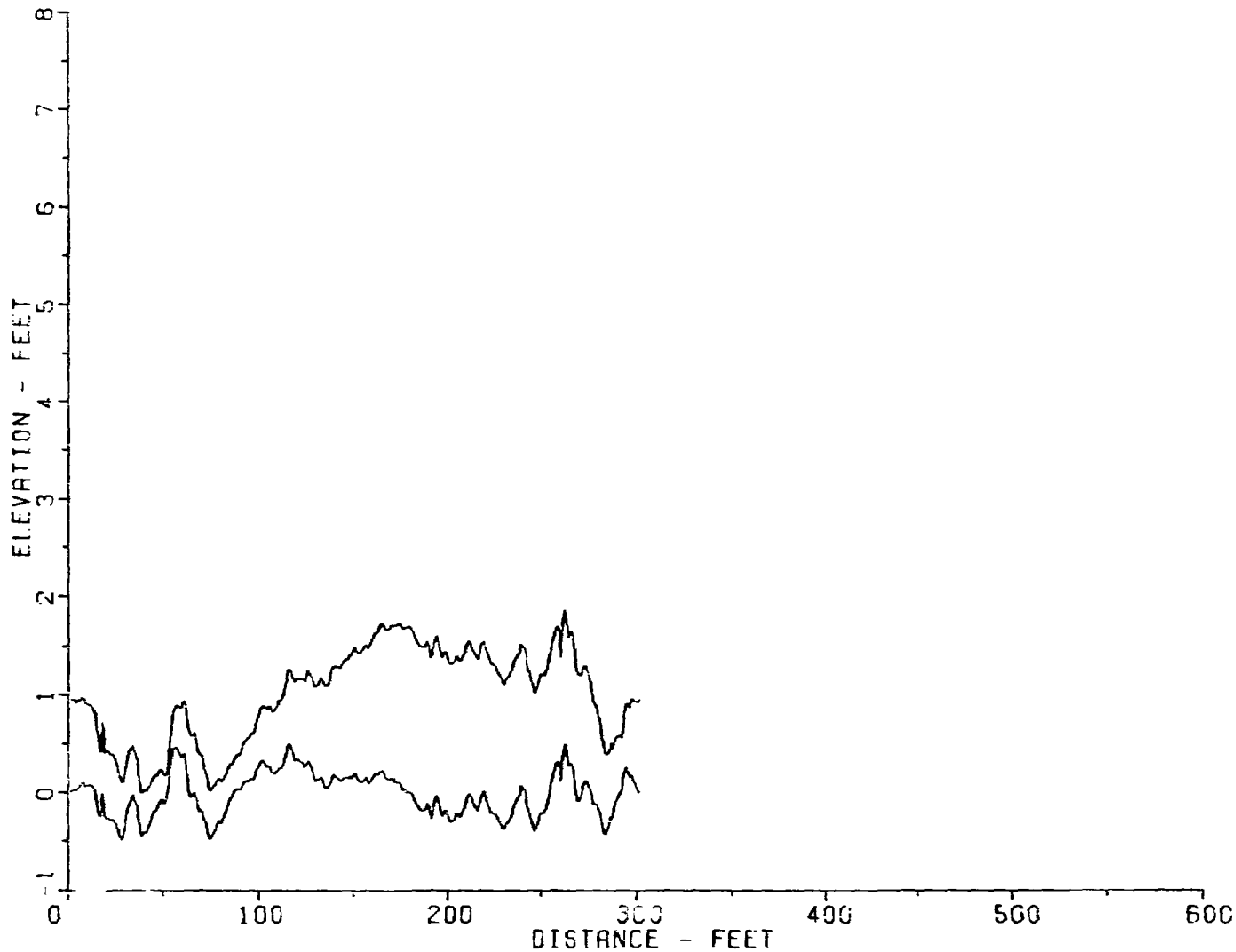


Figure 21

RD16

5/22/78

RD16

APG TERRAIN 12 RMS=1.72 ADDED TO THE DISK ON 11-MAR-77

NUMBER OF POINTS = 361

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.09	.01	.04	.01	.04	.07	.10	.09	.06	.07
11	.06	.08	.05	.01	-.10	-.23	-.24	-.01	-.23	-.07
21	-.26	-.28	-.28	-.29	-.33	-.37	-.46	-.49	-.43	-.31
31	-.18	-.11	-.06	-.03	-.11	-.15	-.31	-.44	-.44	-.41
41	-.49	-.34	-.31	-.24	-.19	-.19	-.14	-.09	-.08	-.12
51	-.09	.03	.21	.35	.44	.47	.45	.40	.36	.30
61	.35	.18	.02	-.05	-.03	.00	-.07	-.16	-.19	-.19
71	-.27	-.33	-.43	-.48	-.47	-.41	-.38	-.38	-.39	-.31
81	-.27	-.23	-.18	-.12	-.06	-.05	.00	.04	.03	.03
91	.05	.11	.12	.14	.11	.15	.12	.17	.24	.20
101	.32	.34	.30	.27	.28	.27	.20	.19	.21	.23
111	.25	.25	.30	.36	.44	.50	.48	.39	.34	.34
121	.33	.31	.29	.26	.28	.33	.30	.24	.14	.12
131	.13	.15	.16	.09	.05	.03	.07	.11	.19	.17
141	.16	.13	.12	.13	.16	.15	.14	.17	.15	.13
151	.20	.14	.11	.10	.13	.15	.13	.09	.11	.15
161	.20	.18	.19	.21	.23	.19	.15	.13	.13	.14
171	.13	.10	.10	.09	.09	.03	.01	.00	.00	.00
181	-.02	-.04	-.10	-.15	-.16	-.18	-.18	-.17	-.11	-.10
191	-.26	-.29	-.28	-.23	-.11	-.19	-.24	-.19	-.19	-.22
201	-.30	-.34	-.27	-.21	-.20	-.26	-.23	-.15	-.14	-.07
211	-.02	-.03	-.09	-.15	-.15	-.16	-.10	-.02	.00	-.06
221	-.12	-.17	-.21	-.22	-.22	-.25	-.30	-.33	-.37	-.38
231	-.33	-.29	-.25	-.23	-.14	-.09	-.05	-.02	.06	.04
241	.01	-.15	-.29	-.27	-.33	-.49	-.37	-.28	-.21	-.21
251	-.21	-.15	-.11	.01	.09	.21	.29	.31	.30	.11
261	.37	.50	.46	.28	.30	.28	.18	.02	-.10	-.02
271	-.01	.08	.11	.09	.04	-.04	-.12	-.13	-.13	-.20
281	-.29	-.36	-.44	-.43	-.36	-.25	-.25	-.10	-.00	.04
291	-.00	.03	.19	.26	.21	.15	.16	.12	.07	.01
301	.00	-1.44	1.12	.00	.01	-.02	-.02	-.06	-.00	-.03

RMS = 2.716 INCHES

TABLE 16

HOUGHTON DATA: SEPT 75 ADDED TO THE DISK ON 23-MAR-77

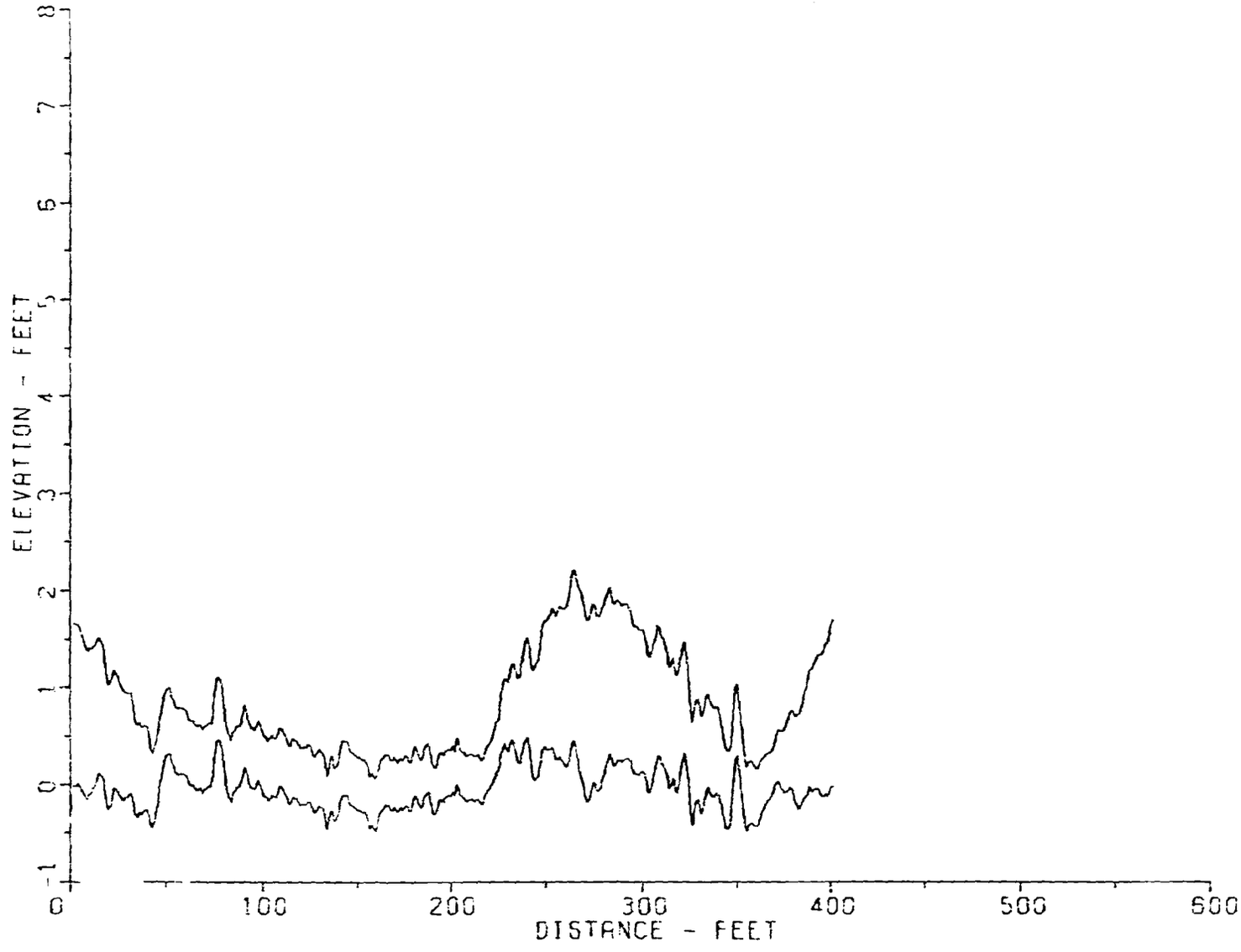
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.01	.12	.20	.23	.20	.14	.08	.07	.04	-.00
11	-.09	-.14	-.13	-.14	-.21	-.29	-.38	-.47	-.48	-.45
21	-.34	-.22	-.17	-.15	-.14	-.13	-.14	-.17	-.19	-.17
31	-.14	-.17	-.21	-.25	-.31	-.42	-.48	-.34	-.21	-.18
41	-.20	-.22	-.14	-.09	-.02	.03	.05	.04	-.01	-.04
51	-.06	-.07	-.08	-.09	-.05	-.00	.01	.03	-.02	.01
61	.03	.01	.01	-.01	.01	.08	.08	.08	.13	.14
71	.14	.09	.06	.10	.15	.20	.23	.23	.11	-.02
81	-.08	.04	.13	.19	.27	.27	.25	.23	.16	.03
91	.01	.02	-.06	-.14	.02	.14	.11	.01	-.15	-.24
101	-.12	.01	.14	.17	.18	.18	.21	.18	.08	-.05
111	-.17	-.14	.11	.26	.36	.43	.36	.20	.03	-.07
121	.01	.22	.38	.37	.23	.06	-.00	.06	.03	-.01
131	.04	.08	.15	.12	.13	.16	.16	.17	.21	.25
141	.28	.24	.17	.19	.16	.11	.12	.11	.06	.04
151	.07	.05	.01	.00	.04	-.01	-.15	-.22	-.23	-.20
161	.32	.41	.35	.21	.03	.00	.02	.06	-.06	-.13
171	-.22	-.25	-.29	-.34	-.44	-.49	-.41	-.29	-.20	-.11
181	-.11	-.14	-.24	-.31	-.28	-.26	-.25	-.22	-.08	-.07
191	-.13	-.21	-.24	-.29	-.14	-.02	.02	.05	.05	.05
201	.08	.10	.09	.08	.02	.00	.03	.07	.08	.09
211	.05	-.01	-.01	-.04	-.09	-.14	-.16	-.19	-.15	-.14
221	-.19	-.19	-.12	.02	.12	.16	.19	.18	.18	.01
231	.17	.44	.17	.07	.14	.16	.14	.14	.19	.25
241	.28	.28	.26	.22	.25	.32	.40	.39	.38	.38
251	.23	.19	.12	.17	.29	.38	.36	.48	.49	.43
261	.35	.34	.34	.25	.17	.19	.23	.24	.17	.16
271	.08	.08	.01	.00	.01	.06	.10	.09	.02	.00
281	.01	.06	-.06	-.24	-.30	-.18	-.02	.22	.41	.48
291	.48	.45	.35	.15	-.10	-.27	-.31	-.22	-.15	-.09
301	.00	.14	.26	.35	.38	.29	.27	.13	.09	.11
311	.12	-.05	-.18	-.07	.01	.02	.08	.18	.11	.00
321	-.18	-.31	-.21	-.09	.02	.05	.11	.11	-.00	-.10
331	-.07	-.02	-.10	-.07	.03	.10	.15	.16	.07	-.08
341	-.07	.04	.01	-.03	-.01	.07	.18	.28	.27	.14
351	-.09	-.32	-.45	-.37	-.25	-.18	-.17	-.19	-.18	-.18
361	-.05	-.03	.00	.00	.02	-.04	-.14	-.21	-.14	-.09
371	-.07	-.10	-.16	-.25	-.37	-.43	-.37	-.30	-.21	-.16
381	-.12	-.14	-.20	-.22	-.22	-.12	-.09	-.16	-.16	-.13
391	-.08	-.02	-.05	-.07	-.07	-.10	-.09	-.07	-.10	-.13
401	.00	-1.00	1.12	.00	.12	.00	.00	.00	.00	.00

RMS = 2.341 INCHES

TABLE 17



RD19

Figure 23

6/22/78

HOUGHTON DATA4 SEPT 75 ADDED TO THE DISK ON 23.MAR.77

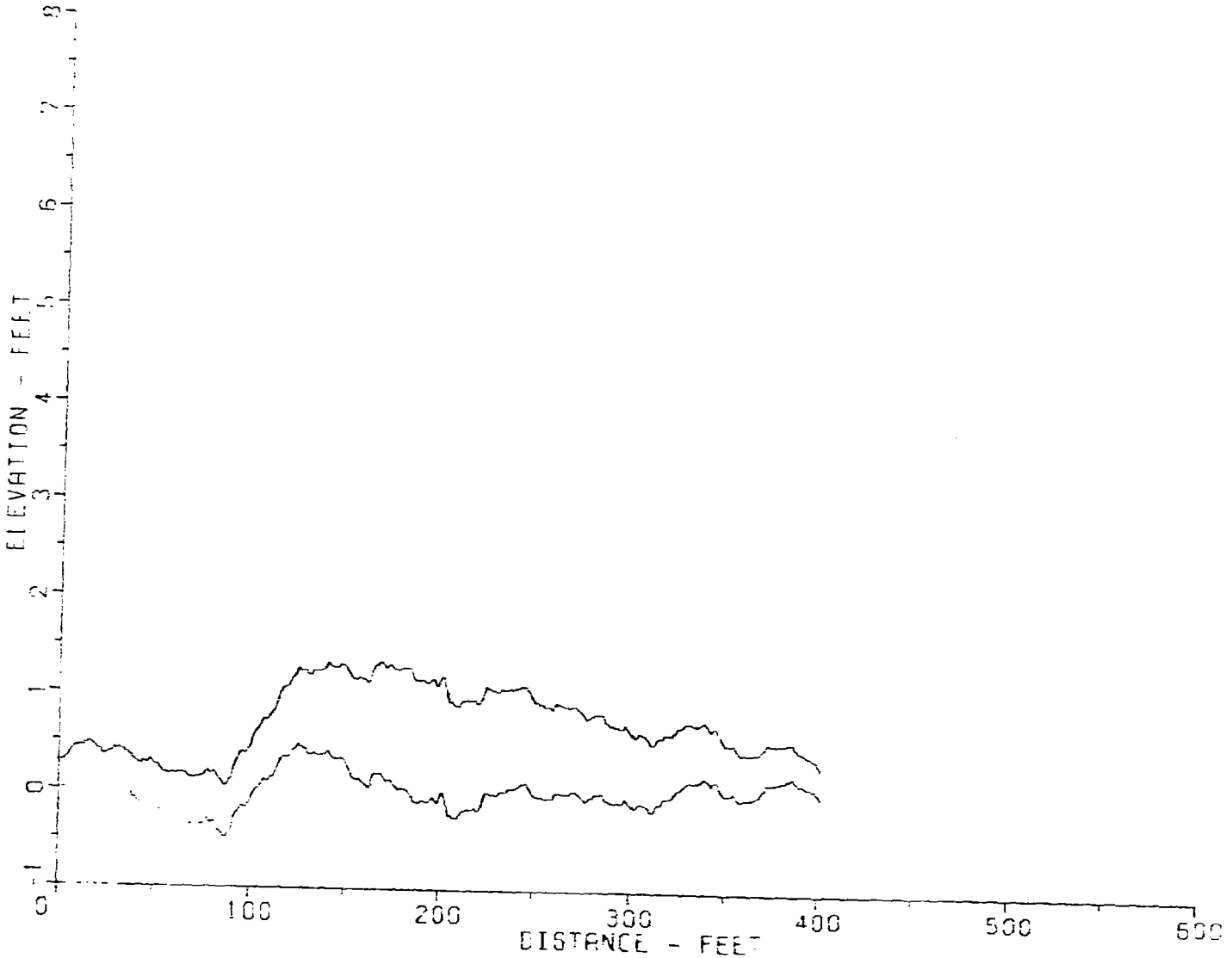
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.03	-.01	.01	-.02	-.06	-.10	-.14	-.15	-.18
11	-.08	-.04	.01	.08	.12	.09	.08	-.04	-.18	-.06
21	-.20	-.11	-.04	-.05	-.08	-.12	-.16	-.16	-.13	-.13
31	-.14	-.09	-.20	-.31	-.34	-.29	-.31	-.28	-.27	-.25
41	-.32	-.02	-.45	-.35	-.25	-.11	.01	.12	.25	.31
51	.32	.34	.23	.18	.12	.10	.12	.12	.16	.08
61	.07	.04	-.01	-.01	-.04	-.08	-.05	-.03	-.09	-.04
71	-.05	-.01	-.03	.04	.27	.41	.46	.45	.39	.21
81	.01	-.08	-.15	-.17	-.08	-.07	-.02	-.09	.02	.10
91	.19	.14	.03	-.03	-.03	-.06	.00	.04	-.01	-.07
101	-.12	-.12	-.16	-.13	-.10	-.12	-.13	-.08	-.02	-.01
111	-.05	-.11	-.14	-.20	-.19	-.12	-.13	-.13	-.18	-.22
121	-.19	-.20	-.20	-.17	-.17	-.24	-.29	-.28	-.23	-.21
131	-.24	-.26	-.31	-.46	-.40	-.26	-.28	-.38	-.37	-.31
141	-.18	-.10	-.11	-.10	-.11	-.18	-.21	-.22	-.24	-.27
151	-.26	-.27	-.29	-.28	-.31	-.39	-.46	-.42	-.44	-.48
161	-.43	-.33	-.26	-.24	-.21	-.22	-.21	-.27	-.28	-.22
171	-.26	-.29	-.24	-.26	-.24	-.21	-.23	-.27	-.27	-.18
181	-.11	-.14	-.20	-.25	-.21	-.13	-.08	-.07	-.16	-.26
191	-.31	-.31	-.21	-.15	-.15	-.18	-.13	-.11	-.11	-.11
201	-.07	-.11	.00	-.05	-.11	-.13	-.14	-.17	-.16	-.15
211	-.15	-.17	-.15	-.15	-.18	-.20	-.18	-.10	-.04	-.02
221	.00	.02	.06	.11	.15	.32	.37	.43	.39	.33
231	.41	.46	.42	.34	.22	.21	.31	.38	.45	.49
241	.40	.22	.07	.04	.07	.10	.21	.36	.39	.36
251	.36	.37	.40	.34	.26	.27	.29	.24	.21	.19
261	.18	.25	.36	.46	.42	.29	.16	.16	.01	-.12
271	-.19	-.16	-.07	.02	.01	-.06	-.06	-.02	.06	.11
281	.18	.25	.32	.25	.19	.21	.25	.24	.22	.25
291	.27	.27	.25	.24	.15	.11	.12	.10	.12	.14
301	.11	.03	-.08	-.08	-.00	.10	.17	.20	.20	.21
311	.20	.14	.08	-.04	-.00	.07	-.03	-.09	-.02	.13
321	.25	.32	.23	.05	-.19	-.41	-.34	-.21	-.16	-.19
331	-.30	-.27	-.15	-.06	-.02	-.10	-.13	-.12	-.09	-.11
341	-.16	-.24	-.34	-.44	-.46	-.44	-.26	.02	.24	.38
351	.18	-.00	-.20	-.39	-.48	-.43	-.39	-.39	-.41	-.43
361	-.41	-.35	-.29	-.25	-.21	-.18	-.16	-.13	-.07	.00
371	.03	.04	-.01	-.06	-.08	-.08	-.05	-.02	-.05	-.12
381	-.20	-.21	-.26	-.22	-.16	-.14	-.11	-.02	-.04	-.08
391	-.05	-.04	-.05	-.08	-.12	-.12	-.09	-.13	-.10	-.02
401	.00	-1.00	1.12	.00	-.23	.00	.00	.00	.00	.00

RMS = 2.570 INCHES

TABLE 18



RD19

Figure 24

8/22/78

HOUGHTON DATA SEPT 75 ADDED TO THE DISK ON 23,MAR,77

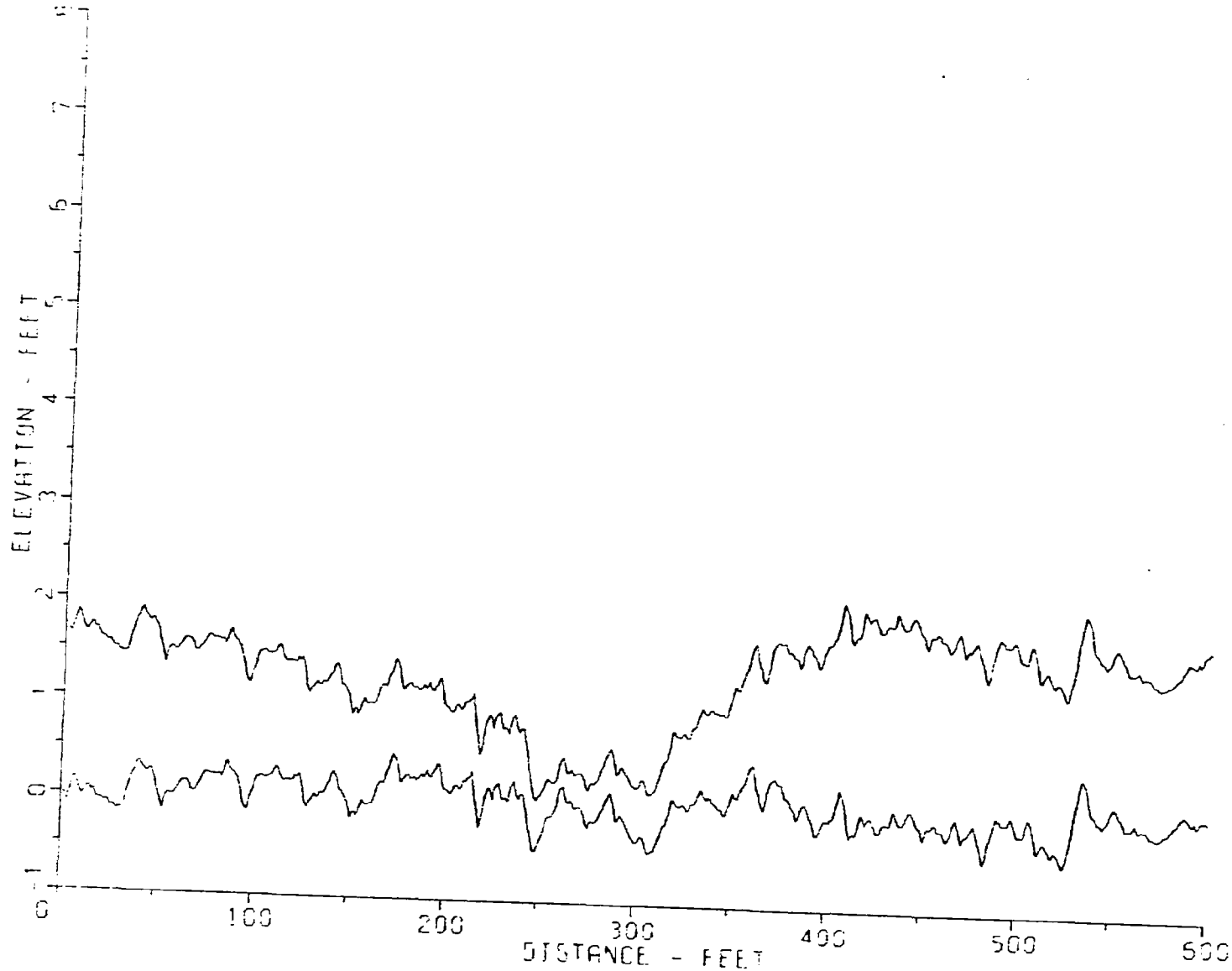
NUMBER OF POINTS = 441

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.09	.11	.01	-.03	.05	.09	.10	.13	.13	.14
11	.13	.14	.13	.15	.16	.15	.13	.12	.12	.08
21	.06	.06	.02	.01	.02	.03	.03	.04	.07	.05
31	.06	.05	.03	.03	-.00	-.00	-.03	-.04	-.08	-.10
41	-.12	-.14	-.13	-.11	-.13	-.14	-.13	-.11	-.14	-.17
51	-.18	-.20	-.22	-.25	-.27	-.27	-.30	-.28	-.28	-.28
61	-.30	-.28	-.28	-.29	-.30	-.30	-.33	-.35	-.36	-.35
71	-.36	-.35	-.38	-.35	-.35	-.34	-.32	-.30	-.34	-.33
81	-.33	-.38	-.37	-.41	-.44	-.47	-.49	-.47	-.43	-.42
91	-.34	-.29	-.23	-.20	-.16	-.15	-.17	-.17	-.13	-.09
101	-.04	.02	.02	.04	.08	.10	.13	.10	.11	.13
111	.14	.16	.19	.24	.29	.33	.35	.36	.36	.36
121	.39	.42	.44	.47	.50	.46	.47	.44	.44	.40
131	.38	.38	.41	.39	.38	.37	.39	.38	.39	.41
141	.42	.38	.36	.34	.35	.33	.35	.34	.33	.31
151	.27	.22	.17	.14	.12	.13	.14	.11	.10	.08
161	.05	.05	.07	.15	.19	.19	.18	.19	.20	.16
171	.12	.12	.13	.11	.09	.07	.05	.03	.04	.04
181	.04	.03	.02	.00	-.04	-.09	-.11	-.10	-.11	-.08
191	-.09	-.09	-.11	-.09	-.07	-.05	-.05	-.10	-.11	-.04
201	.01	.00	-.09	-.19	-.24	-.23	-.25	-.26	-.27	-.26
211	-.22	-.19	-.18	-.18	-.18	-.17	-.17	-.15	-.18	-.19
221	-.17	-.11	-.08	.00	.01	.00	-.01	-.01	-.01	-.02
231	-.01	.02	.02	.02	.02	.05	.05	.06	.06	.08
241	.08	.09	.11	.09	.12	.08	.07	.03	-.00	-.02
251	-.01	-.03	-.03	-.03	-.05	-.05	-.04	-.04	-.06	-.03
261	.02	.02	.01	.01	-.00	.00	.01	-.01	.02	.03
271	.04	.01	.01	-.01	-.03	-.06	-.07	-.05	-.03	-.02
281	.00	-.03	.01	.01	.02	-.01	-.05	-.06	-.07	-.08
291	-.08	-.09	-.07	-.09	-.08	-.08	-.03	-.06	-.08	-.12
301	-.10	-.14	-.12	-.08	-.09	-.09	-.10	-.11	-.13	-.16
311	-.16	-.15	-.09	-.09	-.08	-.08	-.03	-.03	-.02	-.02
321	-.02	.00	.03	.06	.07	.09	.10	.13	.13	.15
331	.15	.14	.13	.15	.14	.16	.18	.19	.18	.16
341	.14	.11	.15	.16	.14	.13	.07	.05	.02	.02
351	.01	.03	.03	.05	.01	-.01	-.04	-.06	-.04	-.03
361	-.03	-.02	-.02	-.02	-.01	.00	.00	.01	.04	.07
371	.09	.14	.13	.14	.14	.16	.14	.16	.15	.16
381	.16	.16	.19	.19	.20	.21	.17	.16	.14	.13
391	.12	.12	.10	.10	.09	.09	.08	.08	.05	.04
401	.00	-1.00	1.12	.00	.01	.00	.00	.00	.00	.00

RMS = 2.242 INCHES

TABLE 19



8021

Figure 25

8/23/78

TABLE 20
RO21

HOUGHTON DATA SEPT 75 ADDED TO THE DISK ON 20.APR.77

NUMBER OF POINTS = 600

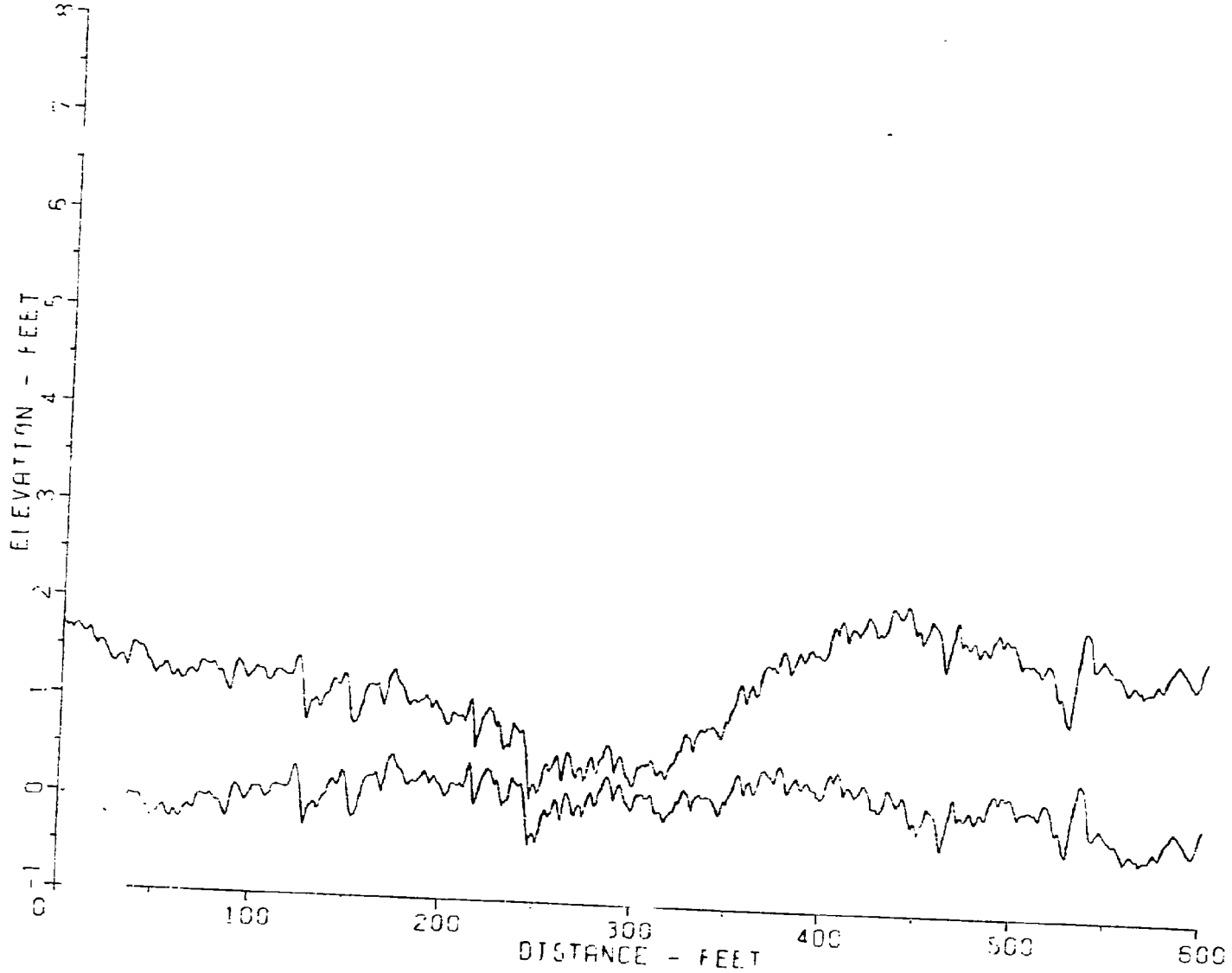
INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.07	-.03	-.08	-.02	.03	.10	.16	.13	.05	-.00
11	-.02	-.01	.03	.06	.08	.02	.04	-.01	-.05	-.06
21	-.05	-.07	-.08	-.07	-.10	-.12	-.12	-.14	-.16	-.15
31	-.15	-.13	-.14	-.06	.05	.12	.19	.24	.26	.33
41	.35	.30	.27	.24	.24	.26	.26	.21	.17	.08
51	.01	-.10	-.14	-.04	-.00	.02	.01	.00	.02	.05
61	.08	.12	.14	.16	.15	.15	.11	.06	.04	.05
71	.09	.12	.16	.20	.25	.24	.23	.22	.22	.22
81	.22	.23	.23	.19	.26	.35	.37	.29	.25	.25
91	.21	.20	.12	.03	-.07	-.12	-.13	-.03	.03	.10
101	.16	.20	.21	.23	.21	.20	.20	.23	.23	.25
111	.29	.32	.30	.23	.19	.18	.19	.19	.20	.19
121	.20	.24	.21	.25	.21	.09	-.04	-.08	-.03	-.01
131	.02	.05	.02	.02	.06	.07	.07	.11	.16	.19
141	.26	.29	.25	.19	.09	.08	.06	.03	-.01	-.00
151	-.18	-.12	-.12	-.17	-.11	-.04	.00	-.04	-.06	-.03
161	-.03	-.03	.01	.07	.14	.19	.19	.18	.21	.30
171	.34	.41	.48	.45	.42	.30	.19	.20	.25	.27
181	.28	.23	.23	.25	.22	.24	.26	.29	.25	.38
191	.33	.26	.25	.30	.34	.40	.40	.29	.17	.13
201	.13	.11	.09	.12	.17	.18	.18	.14	.18	.23
211	.22	.26	.27	.33	.21	.05	-.09	-.20	-.16	-.03
221	.06	.13	.17	.14	.04	.14	.19	.21	.14	.05
231	.06	.06	.01	.12	.20	.23	.16	.08	.06	.11
241	.10	.01	-.10	-.22	-.30	-.40	-.47	-.47	-.41	-.37
251	-.31	-.24	-.17	-.12	-.11	-.11	-.08	-.04	.01	.11
261	.18	.20	.14	.04	.03	.05	.02	-.02	-.01	-.01
271	-.01	-.05	-.10	-.18	-.22	-.15	-.15	-.17	-.16	-.14
281	-.09	-.04	-.01	.03	.09	.13	.15	.07	-.04	-.14
291	-.13	-.08	-.10	-.15	-.18	-.22	-.27	-.31	-.33	-.36
301	-.35	-.32	-.28	-.29	-.35	-.42	-.46	-.46	-.44	-.43
311	-.39	-.33	-.27	-.21	-.17	-.15	-.10	-.00	.10	.10
321	.06	.04	.03	.05	.06	.02	-.01	.00	.06	.07
331	.07	.11	.17	.21	.18	.13	.11	.14	.13	.08
341	.06	.05	.02	.01	.00	-.05	-.05	.02	.07	.15
351	.19	.13	.13	.18	.22	.26	.29	.35	.40	.46
361	.48	.36	.23	.19	.09	.02	.02	.13	.24	.31
371	.33	.34	.34	.29	.28	.28	.20	.15	.15	.10
381	.06	.04	.01	-.08	-.06	.04	.07	.09	.05	.01
391	-.06	-.09	-.15	-.23	-.23	-.18	-.14	-.10	-.08	-.09
401	-.09	-.06	-.04	.02	.09	.17	.24	.18	.10	-.02
411	-.17	-.25	-.20	-.20	-.23	-.16	-.06	.00	-.05	-.11
421	-.07	-.05	-.04	-.10	-.13	-.18	-.19	-.17	-.11	-.09
431	-.10	-.11	-.09	-.04	.05	.02	-.05	-.10	-.10	-.18
441	-.07	-.01	.03	.04	.02	-.03	-.09	-.11	-.13	-.21
451	-.25	-.13	-.11	-.13	-.11	-.08	-.09	-.14	-.14	-.15
461	-.17	-.23	-.24	-.22	-.17	-.09	-.05	-.02	-.09	-.19
471	-.26	-.24	-.18	-.20	-.14	-.11	-.08	-.12	-.19	-.27
481	-.34	-.42	-.47	-.38	-.25	-.20	-.13	-.06	.00	-.01
491	-.02	-.06	-.06	-.06	-.06	-.02	.01	-.02	-.09	-.17
501	-.18	-.16	-.19	-.16	-.07	-.00	-.01	-.07	-.15	-.26

TABLE 20 (Cont'd)

511	-.34	-.34	-.27	-.24	-.24	-.29	-.32	-.36	-.37	-.33
521	-.34	-.37	-.40	-.46	-.48	-.46	-.35	-.27	-.14	-.03
531	.12	.23	.34	.42	.43	.38	.29	.17	.07	.06
541	.04	-.01	-.02	-.04	-.06	-.03	-.01	.03	.08	.12
551	.15	.12	.08	.03	.02	-.03	-.08	-.07	-.07	-.07
561	-.08	-.02	-.07	-.10	-.08	-.08	-.09	-.07	-.11	-.14
571	-.14	-.16	-.17	-.18	-.16	-.15	-.13	-.12	-.10	-.08
581	-.06	-.03	-.02	.00	.03	.05	.07	.09	.06	.03
591	.00	-.01	.03	-.03	-.01	.02	.03	.03	.04	.00

RMS = 2.254 INCHES



R022

Figure 26

5/23/78

TABLE 21
RD22

HOUGHTON DATA7 SEPT 75 ADDED TO THE DISK ON 23.MAR.77

NUMBER OF POINTS = 800

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.04	-.03	-.02	-.06	-.00	.02	.02	-.01	-.03
11	-.05	-.05	-.02	.01	-.02	-.08	-.11	-.14	-.18	-.20
21	-.09	-.11	-.14	-.19	-.22	-.25	-.26	-.25	-.21	-.19
31	-.17	-.17	-.22	-.26	-.16	-.07	-.01	-.01	-.02	-.03
41	-.02	-.02	-.05	-.11	-.14	-.15	-.17	-.24	-.27	-.24
51	-.19	-.18	-.16	-.13	-.12	-.15	-.23	-.24	-.23	-.18
61	-.18	-.23	-.24	-.22	-.18	-.14	-.12	-.11	-.14	-.15
71	-.13	-.03	.01	.01	-.01	-.02	-.01	-.08	.02	-.01
81	-.05	-.06	-.04	-.06	-.12	-.18	-.22	-.21	-.11	.01
91	.10	.13	.11	.08	.03	-.02	-.05	-.02	.02	.06
101	.10	.11	.09	.11	.09	.07	.00	-.01	.01	.04
111	.09	.13	.14	.14	.12	.13	.11	.11	.11	.13
121	.17	.25	.33	.32	.23	.09	-.10	-.28	-.20	-.12
131	-.08	-.07	-.04	-.07	-.12	-.09	-.01	.02	.04	.07
141	.13	.19	.21	.17	.16	.16	.23	.29	.28	.21
151	.06	-.12	-.19	-.17	-.15	-.09	.00	.07	.15	.21
161	.25	.25	.26	.25	.26	.29	.22	.15	.06	.18
171	.27	.37	.44	.47	.48	.48	.35	.33	.32	.29
181	.21	.17	.17	.21	.22	.20	.21	.24	.25	.26
191	.31	.28	.26	.19	.24	.26	.24	.20	.19	.15
201	.09	.06	.08	.12	.20	.21	.19	.18	.18	.21
211	.16	.16	.25	.36	.41	.24	-.02	-.00	.10	.10
221	.24	.30	.32	.37	.33	.35	.24	.19	.25	.10
231	.07	-.02	.01	.05	.04	.19	.28	.25	.22	.20
241	.21	.23	.12	-.01	-.19	-.41	-.34	-.29	-.32	-.38
251	-.31	-.22	-.12	-.06	-.04	-.11	-.07	-.05	.01	.07
261	.02	-.12	-.15	.01	.14	.14	.08	.02	-.07	-.09
271	-.02	.02	-.00	-.10	-.04	.05	.11	.16	.13	.02
281	.03	.12	.18	.20	.29	.33	.33	.27	.18	.07
291	.15	.23	.26	.21	.14	.07	.05	.02	-.02	.01
301	.10	.16	.13	.15	.15	.11	.13	.11	.15	.11
311	.03	-.03	-.03	-.02	-.04	-.11	-.12	-.06	-.04	-.01
321	-.01	.02	.09	.07	.14	.20	.23	.17	.16	.06
331	.00	.10	.15	.17	.18	.14	.14	.15	.14	.14
341	.14	.09	.06	.01	-.04	-.03	.07	.11	.08	.15
351	.19	.22	.29	.36	.41	.38	.30	.18	.21	.30
361	.33	.26	.20	.21	.23	.33	.40	.44	.45	.42
371	.38	.39	.36	.31	.37	.45	.49	.47	.42	.31
381	.21	.23	.28	.31	.36	.38	.31	.26	.27	.30
391	.33	.34	.29	.26	.25	.24	.19	.18	.16	.18
401	.23	.30	.38	.43	.49	.34	.41	.46	.41	.33
411	.21	.25	.30	.29	.26	.23	.18	.22	.24	.27
421	.31	.34	.30	.24	.17	.09	.08	.10	.05	.05
431	.07	.10	.20	.28	.28	.23	.19	.15	.10	.13
441	.17	.22	.19	.09	.01	-.06	-.10	-.05	-.15	-.17
451	-.13	-.05	-.02	.05	.11	.08	.06	.05	.02	-.06
461	-.17	-.32	-.34	-.19	-.10	-.01	.07	.18	.22	.07
471	-.01	.03	.02	-.00	-.01	.05	.08	.06	.01	-.04
481	.01	.05	.07	.04	.01	.05	.13	.18	.23	.27
491	.25	.18	.18	.26	.25	.21	.22	.24	.23	.17
501	.12	.05	.02	.08	.08	.09	.08	.11	.11	.08
511	.08	.09	.04	.02	.10	.14	.19	.18	.17	.11

TABLE 21 (Cont'd)

521	.04	-.07	-.13	-.09	-.11	-.20	-.29	-.34	-.34	-.17
531	.01	.12	.21	.31	.39	.42	.36	.29	.10	.03
541	-.14	-.16	-.15	-.10	-.06	-.05	-.09	-.12	-.14	-.16
551	-.18	-.21	-.21	-.20	-.22	-.27	-.30	-.35	-.39	-.37
561	-.33	-.30	-.31	-.34	-.36	-.34	-.40	-.38	-.37	-.36
571	-.35	-.36	-.32	-.29	-.27	-.31	-.33	-.31	-.25	-.19
581	-.17	-.14	-.13	-.08	-.05	-.06	-.10	-.13	-.16	-.13
591	-.21	-.26	-.27	-.30	-.29	-.26	-.22	-.13	-.06	-.04

RMS = 2.344 INCHES

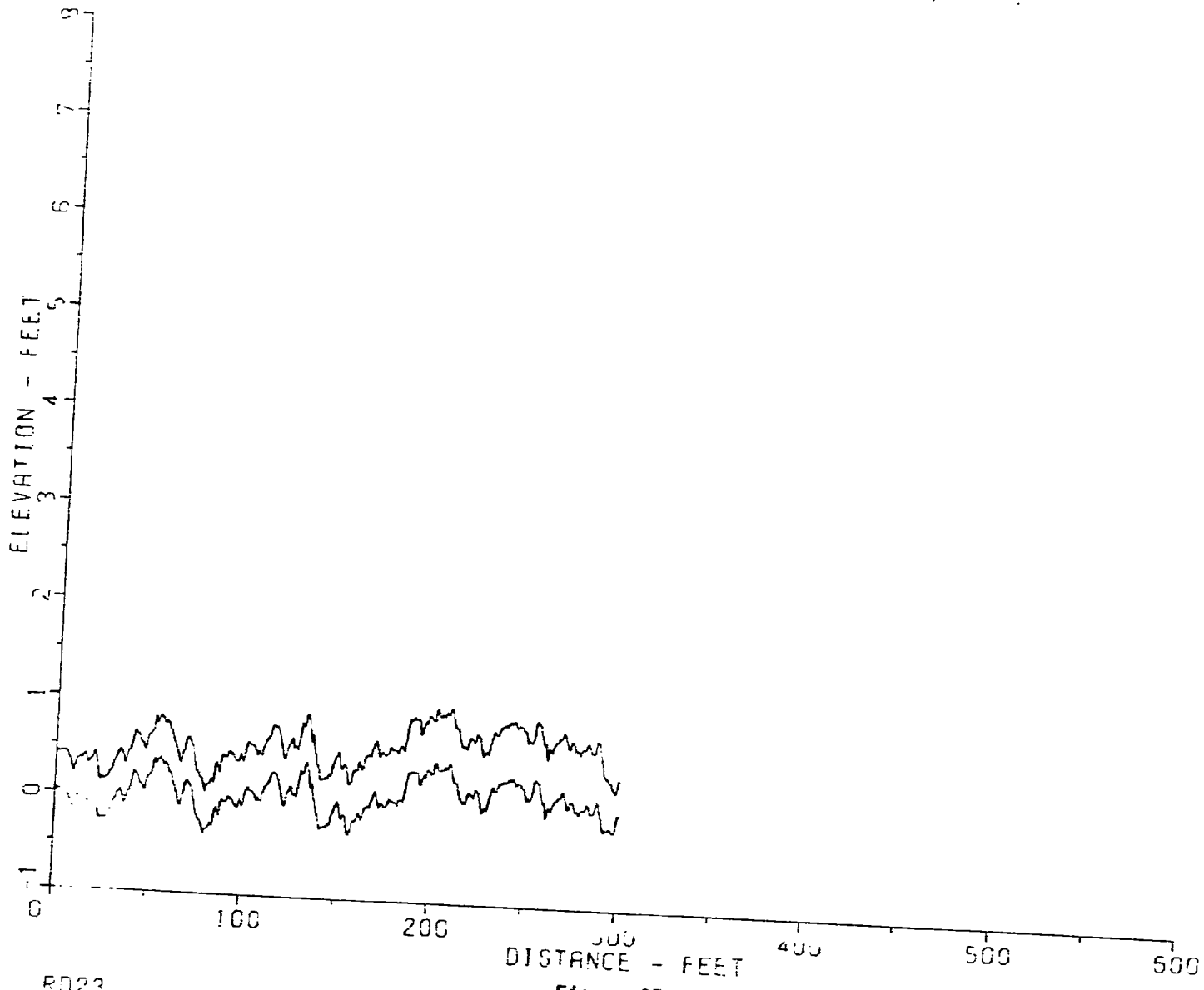


Figure 27

5/23/78

TABLE 22
RD23

PARADIGM WOOD COURSE ADDED TO THE DISK ON 23.MAR.77

NUMBER OF POINTS = 600

INTERVAL IN INCHES = 6

POINT	ELEVATIONS IN FEET									
1	.00	.03	.01	.02	.03	.03	.02	.03	.02	.03
11	.03	.01	-.04	-.05	-.08	-.10	-.13	-.16	-.18	-.15
21	-.10	-.07	-.05	-.04	-.03	-.04	-.05	-.05	-.03	-.01
31	-.00	-.02	-.06	-.10	-.10	-.08	-.06	-.05	-.05	-.01
41	.01	.02	-.02	-.08	-.14	-.21	-.26	-.24	-.27	-.25
51	-.27	-.26	-.25	-.25	-.24	-.24	-.25	-.17	-.16	-.15
61	-.12	-.08	-.07	-.06	-.04	-.01	.01	.02	.04	.01
71	.00	-.03	-.09	-.11	-.08	-.03	.00	.03	.03	.00
81	.11	.16	.20	.24	.22	.21	.19	.19	.15	.12
91	.11	.10	.10	.08	.04	.05	.13	.19	.19	.26
101	.21	.22	.23	.29	.36	.38	.33	.32	.36	.37
111	.37	.39	.36	.35	.32	.31	.33	.32	.31	.28
121	.25	.23	.24	.20	.16	.12	.10	.06	.04	.01
131	-.04	-.08	-.10	-.08	-.02	.01	.03	.00	.14	.16
141	.16	.15	.12	.11	.08	.06	.01	-.05	-.11	-.16
151	-.18	-.20	-.22	-.24	-.25	-.26	-.29	-.31	-.36	-.38
161	-.33	-.34	-.32	-.32	-.30	-.27	-.27	-.28	-.38	-.22
171	-.14	-.10	-.11	-.14	-.19	-.18	-.09	-.03	-.01	-.04
181	-.03	-.04	-.05	-.03	.01	.01	-.01	-.02	.00	-.02
191	-.05	-.08	-.09	-.08	-.10	-.08	-.03	-.01	-.05	-.09
201	-.07	-.02	.04	.09	.13	.12	.10	.08	.07	.08
211	.06	.06	.03	.01	-.02	-.01	.02	-.01	-.02	-.03
221	.01	.06	.09	.13	.14	.15	.17	.17	.21	.26
231	.27	.27	.28	.27	.26	.27	.26	.22	.16	.12
241	.08	.02	-.04	-.06	-.06	-.04	.02	.00	.09	.10
251	.14	.16	.10	.05	.06	.06	.05	.04	.10	.17
261	.28	.31	.29	.27	.28	.30	.37	.48	.37	.33
271	.25	.14	.13	.19	.12	.04	-.03	-.10	-.14	-.13
281	-.18	-.25	-.29	-.28	-.27	-.27	-.27	-.28	-.27	-.28
291	-.22	-.22	-.24	-.23	-.18	-.14	-.10	-.06	-.04	-.02
301	.01	-.01	-.07	-.14	-.17	-.17	-.13	-.11	-.14	-.17
311	-.23	-.32	-.33	-.33	-.31	-.26	-.21	-.18	-.19	-.17
321	-.18	-.16	-.11	-.09	-.13	-.18	-.18	-.13	-.08	-.06
331	-.04	-.04	-.03	-.02	-.05	-.03	.03	.06	.06	.13
341	.13	.10	.08	.02	-.04	-.02	.01	.01	-.00	-.02
351	-.02	-.02	-.01	.00	.02	.06	.04	.03	.03	.02
361	.03	.03	.02	-.01	.01	.05	.06	.07	.05	.03
371	.03	.10	.19	.25	.29	.34	.34	.33	.33	.36
381	.36	.34	.34	.34	.35	.35	.31	.23	.21	.20
391	.28	.32	.33	.36	.33	.38	.38	.37	.37	.36
401	.33	.33	.37	.43	.45	.43	.39	.37	.37	.37
411	.39	.37	.36	.38	.42	.42	.39	.40	.44	.46
421	.44	.39	.34	.30	.26	.25	.25	.25	.20	.14
431	.10	.06	.06	.04	.07	.06	.03	.05	.11	.16
441	.16	.15	.14	.13	.11	.10	.15	.19	.18	.16
451	.14	.08	.03	-.02	-.04	-.03	.00	.01	.00	-.02
461	.02	.07	.12	.16	.18	.23	.21	.19	.16	.13
471	.22	.24	.26	.26	.27	.27	.28	.29	.27	.28
481	.29	.30	.31	.32	.29	.31	.31	.33	.29	.27
491	.25	.27	.29	.27	.28	.27	.24	.22	.21	.20
501	.15	.10	.13	.12	.10	.09	.12	.16	.22	.30
511	.33	.32	.31	.29	.27	.22	.17	.12	.08	.00

TABLE 22 (Cont'd)

521	.09	.03	-.07	-.01	.04	.02	.02	.00	.05	.08
531	.08	.11	.11	.12	.13	.15	.15	.16	.17	.21
541	.21	.17	.12	.07	.04	.04	.06	.11	.10	.11
551	.09	.05	.01	.00	.02	.02	-.01	-.02	.02	.04
561	.04	.03	.04	.05	.09	.10	.08	.06	.03	-.01
571	.00	-.01	-.01	.03	.00	.12	.11	.10	.05	-.01
581	-.05	-.10	-.15	-.19	-.18	-.18	-.16	-.16	-.10	-.10
591	-.16	-.16	-.19	-.19	-.20	-.19	-.15	-.07	-.01	.00

RMS = 2.17M INCHES
END JOB DAVE

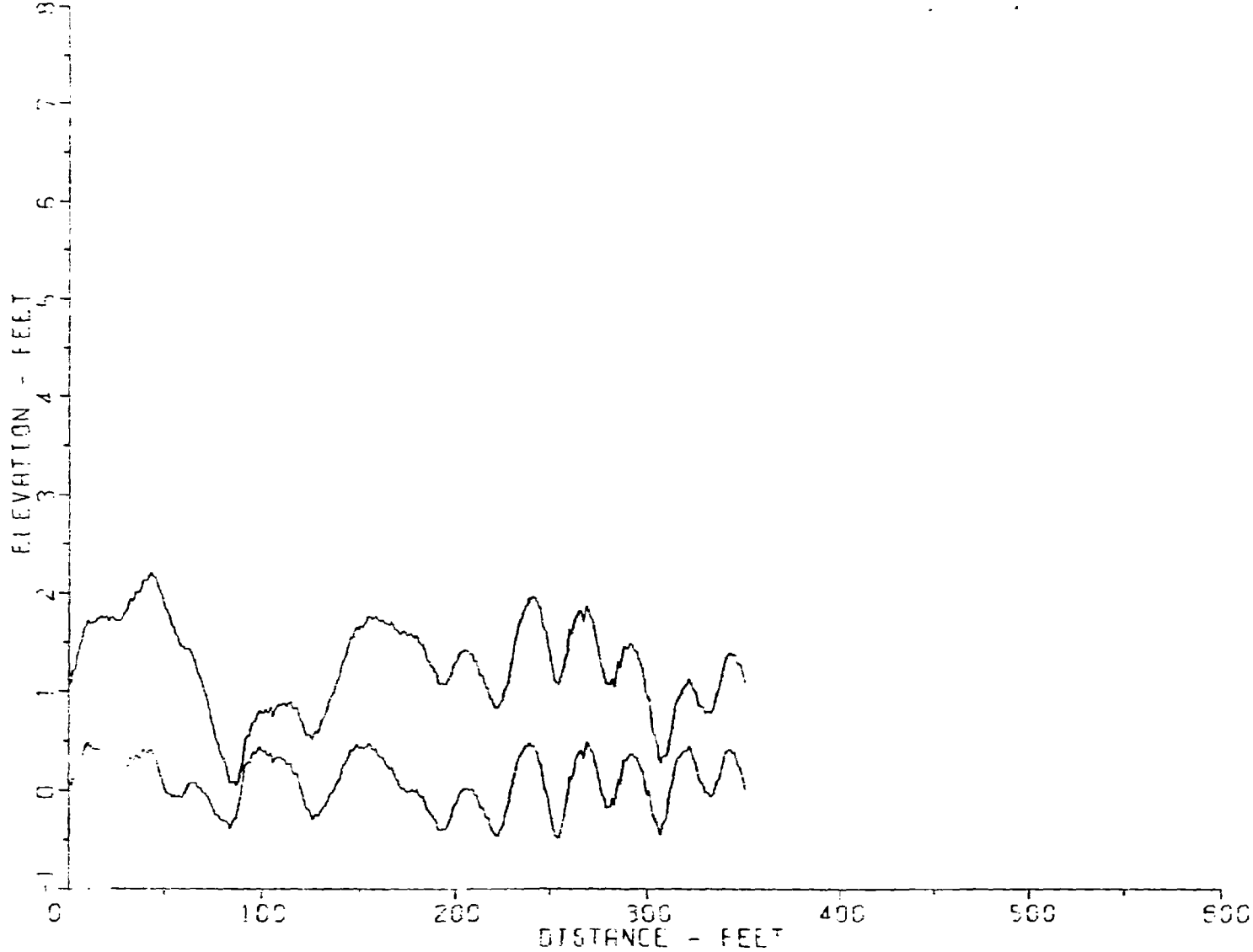


Figure 28

RD24

6/23/78

FORT KNOX CTA1 MAY 76 ADDED TO THE DISK ON 24.MAR.77

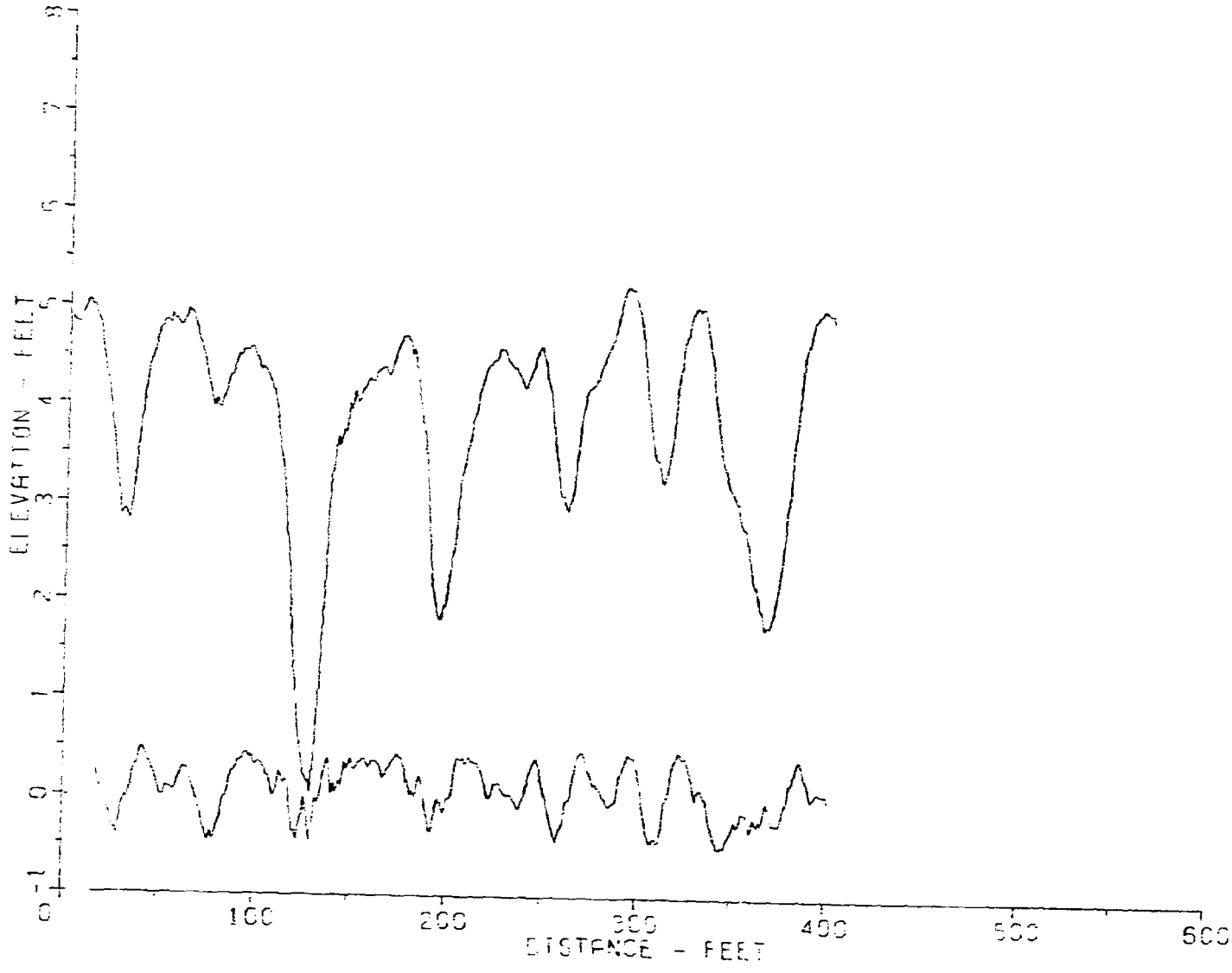
NUMBER OF POINTS = 361

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.01	.11	.10	.15	.24	.30	.33	.42	.46	.40
11	.48	.42	.42	.41	.42	.42	.42	.38	.37	.38
21	.30	.32	.31	.26	.25	.22	.21	.22	.24	.28
31	.25	.34	.30	.31	.36	.34	.33	.36	.42	.39
41	.37	.41	.42	.37	.35	.27	.21	.14	.06	.00
51	-.02	-.04	-.04	-.07	-.04	-.08	-.05	-.08	-.06	-.03
61	-.01	.05	.07	.08	.08	.08	.03	.03	.02	-.01
71	-.03	-.06	-.11	-.14	-.18	-.25	-.25	-.27	-.30	-.30
81	-.31	-.32	-.34	-.39	-.34	-.29	-.29	-.20	-.08	.02
91	.15	.26	.29	.29	.35	.39	.37	.40	.45	.41
101	.38	.41	.36	.35	.39	.28	.33	.34	.34	.32
111	.32	.31	.26	.28	.27	.20	.16	.17	.12	.03
121	-.04	-.10	-.19	-.21	-.25	-.30	-.28	-.24	-.27	-.24
131	-.19	-.16	-.15	-.10	-.04	-.02	.01	.05	.11	.12
141	.18	.26	.27	.32	.38	.42	.40	.44	.48	.43
151	.45	.42	.45	.45	.40	.47	.42	.43	.41	.36
161	.34	.34	.29	.26	.24	.21	.23	.16	.11	.11
171	.04	.02	.03	.00	-.02	-.01	.01	-.01	-.02	.02
181	-.05	-.07	-.06	-.11	-.20	-.21	-.25	-.26	-.30	-.32
191	-.39	-.40	-.39	-.39	-.39	-.34	-.30	-.25	-.17	-.13
201	-.10	-.04	-.01	.01	.03	.02	.01	.01	.08	-.00
211	-.05	-.07	-.17	-.18	-.20	-.26	-.28	-.34	-.39	-.44
221	-.46	-.46	-.43	-.38	-.34	-.24	-.20	-.12	.01	.09
231	.15	.23	.31	.36	.39	.43	.46	.45	.48	.46
241	.46	.42	.37	.30	.25	.10	.01	-.02	-.15	-.23
251	-.34	-.46	-.47	-.49	-.44	-.36	-.24	-.15	-.03	.15
261	.12	.20	.30	.35	.40	.41	.31	.40	.50	.46
271	.40	.38	.28	.21	.11	-.02	-.06	-.11	-.16	-.17
281	-.16	-.18	-.16	-.06	.12	.06	.18	.31	.38	.31
291	.37	.37	.35	.33	.33	.26	.20	.18	.03	-.05
301	-.01	-.13	-.25	-.29	-.33	-.43	-.45	-.37	-.31	-.27
311	-.15	.00	.08	.19	.29	.32	.34	.37	.40	.41
321	.42	.46	.39	.32	.28	.20	.11	.08	.05	-.02
331	-.02	-.03	-.07	-.04	-.01	.09	.13	.17	.26	.33
341	.39	.41	.42	.37	.38	.35	.25	.23	.17	.09
351	.01	-1.00	1.12	.00	.11	.00	.00	.00	.00	.00

RMS = 3.171 INCHES

TABLE 23



5025

Figure 29

9/23/79

FIRST PROF CTA2 MAY 1976 ADDED TO THE DISK ON 18.APR.77

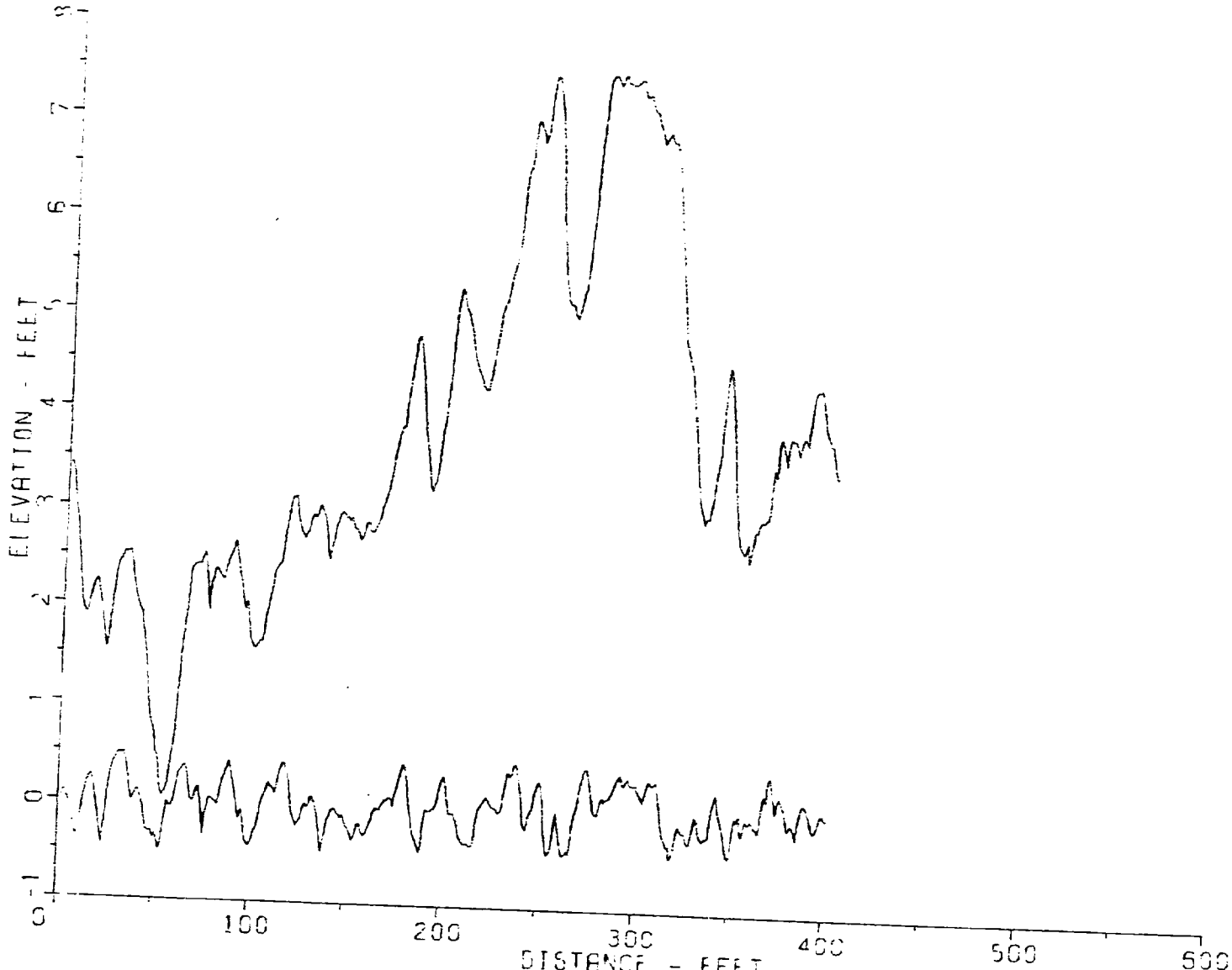
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.06	-.03	-.01	.02	.05	.11	.20	.29	.38	.44
11	.48	.46	.50	.48	.48	.43	.33	.22	.14	.03
21	.00	-.03	-.07	-.14	-.21	-.31	-.34	-.35	-.40	-.24
31	-.13	-.05	.00	-.04	.07	.10	.23	.31	.31	.30
41	.48	.49	.46	.42	.38	.32	.27	.27	.17	.11
51	.01	.06	-.00	.10	.08	.09	.08	.06	.09	.13
61	.18	.23	.30	.30	.29	.22	.18	.12	.05	-.02
71	-.03	-.10	-.23	-.30	-.36	-.45	-.44	-.37	-.43	-.41
81	-.33	-.27	-.21	-.08	-.01	.02	.08	.19	.27	.28
91	.31	.37	.39	.39	.44	.46	.45	.39	.42	.34
101	.32	.37	.36	.34	.31	.28	.21	.21	.14	.02
111	.03	.08	.18	.26	.21	.14	.18	.15	-.01	-.22
121	-.35	-.34	-.44	-.31	-.22	-.17	.00	-.14	-.25	-.44
131	-.30	-.13	.00	-.05	.01	.13	.24	.34	.41	.28
141	.04	.16	.05	.10	.16	.12	.21	.37	.20	.38
151	.41	.29	.20	.32	.37	.37	.40	.40	.36	.31
161	.35	.38	.38	.37	.36	.33	.27	.20	.23	.20
171	.32	.35	.39	.43	.45	.43	.41	.36	.29	.17
181	.18	.13	.07	.02	.08	.16	.22	.13	.02	-.10
191	-.19	-.33	-.33	-.20	-.19	.00	-.04	-.04	-.15	-.09
201	.00	.01	.05	.16	.39	.42	.40	.40	.43	.36
211	.39	.44	.38	.38	.38	.37	.34	.30	.26	.17
221	.09	.01	.01	.06	.16	.15	.16	.14	.10	.06
231	.05	.04	.06	.05	-.00	-.02	-.05	-.10	-.09	.00
241	.06	.12	.19	.28	.34	.41	.41	.36	.29	.16
251	.06	.00	-.07	-.18	-.26	-.31	-.39	-.42	-.33	-.20
261	-.25	-.16	.00	.01	.06	.17	.24	.37	.46	.48
271	.49	.45	.38	.32	.26	.23	.14	.17	.13	.11
281	.08	.03	.01	-.01	-.07	-.08	-.04	-.02	.01	.13
291	.25	.32	.36	.42	.48	.45	.43	.44	.38	.28
301	.21	.09	-.06	-.19	-.30	-.36	-.43	-.43	-.38	-.30
311	-.43	-.41	-.27	-.14	.00	.05	.11	.24	.34	.41
321	.45	.50	.49	.42	.44	.44	.37	.30	.22	.09
331	.01	.09	.12	.11	.07	.02	-.01	-.14	-.25	-.31
341	-.39	-.44	-.49	-.49	-.46	-.45	-.48	-.39	-.35	-.31
351	-.27	-.20	-.26	-.23	-.19	-.11	-.13	-.13	-.21	-.30
361	-.28	-.17	-.22	-.25	-.19	-.23	-.18	-.07	.00	-.07
371	-.14	-.23	-.22	-.23	-.24	-.21	-.14	-.06	-.02	.00
381	.19	.20	.25	.33	.42	.44	.37	.28	.24	.18
391	.12	.01	.04	.05	.10	.10	.08	.07	.07	.08
401	.01	-1.09	1.12	.00	-.03	.00	.00	.00	.00	.00

RMS = 3.088 INCHES

TABLE 24



R025

Figure 30

5/23/78

FORT KNOX STA1 MAY 1976 ADDED TO THE DISK ON 18.APR.77

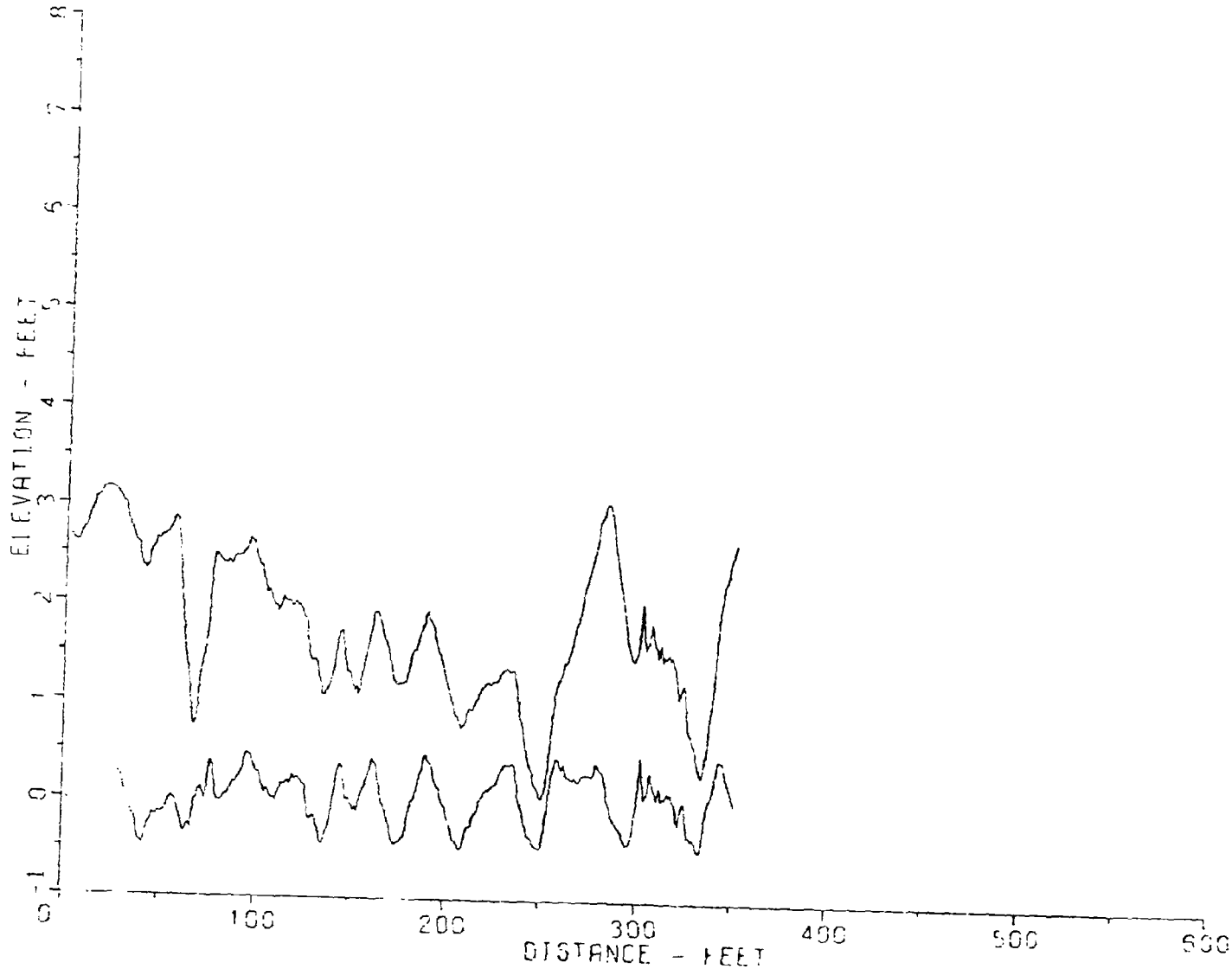
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.12	.04	.07	.00	-.06	-.16	-.25	-.36	-.37
11	-.30	-.16	.01	.10	.19	.25	.26	.18	.07	-.03
21	-.18	-.35	-.44	-.28	-.06	.13	.29	.39	.41	.46
31	.49	.48	.49	.49	.39	.23	.11	.01	.04	.06
41	.12	.25	.03	-.05	-.18	-.30	-.32	-.32	-.31	-.35
51	-.33	-.42	-.49	-.43	-.30	-.16	.00	-.04	-.05	.01
61	.07	.19	.29	.33	.37	.39	.35	.19	.02	.01
71	.02	.10	.16	.06	-.11	-.34	-.11	-.04	.05	.04
81	.02	.01	-.02	.03	.15	.24	.29	.36	.43	.36
91	.24	.15	.02	-.11	-.16	-.06	-.19	-.35	-.41	-.43
101	-.40	-.34	-.28	-.28	-.14	.01	.08	.12	.16	.22
111	.18	.15	.11	.15	.28	.36	.43	.43	.36	.30
121	.08	-.06	-.13	-.18	-.22	-.16	-.14	-.03	.02	-.02
131	.01	.08	.10	.02	-.03	-.14	-.34	-.47	-.34	-.26
141	-.15	-.12	-.04	-.02	-.05	-.08	-.08	-.13	-.09	-.17
151	-.22	-.23	-.29	-.34	-.31	-.25	-.18	-.18	-.27	-.25
161	-.27	-.25	-.19	-.13	-.05	.00	-.02	-.03	.03	.06
171	.08	.07	.10	.08	.01	.13	.20	.29	.38	.46
181	.41	.26	.05	-.06	-.19	-.27	-.33	-.40	-.45	-.35
191	-.16	.00	-.02	-.03	-.00	.01	.03	.11	.19	.28
201	.34	.27	.06	-.05	-.05	-.04	-.00	-.13	-.28	-.30
211	-.34	-.35	-.34	-.36	-.37	-.36	-.30	-.15	.00	.06
221	.08	.11	.14	.11	.06	.04	.02	.02	-.02	-.01
231	.02	.18	.32	.40	.38	.38	.47	.49	.40	.25
241	.07	-.12	-.19	-.19	-.04	.02	.03	.19	.26	.31
251	.25	.07	-.19	-.37	-.44	-.39	-.32	-.16	.00	-.11
261	-.27	-.40	-.44	-.42	-.38	-.43	-.29	-.12	.01	.09
271	.21	.32	.41	.46	.45	.33	.19	.03	-.01	-.05
281	.05	.13	.16	.12	.16	.16	.19	.23	.29	.32
291	.37	.40	.30	.29	.33	.37	.31	.29	.30	.30
301	.25	.20	.17	.12	.21	.27	.34	.32	.30	.33
311	.33	.19	.03	-.09	-.21	-.27	-.32	-.30	-.45	-.49
321	-.30	-.18	-.10	-.14	-.17	-.17	-.23	-.28	-.28	-.19
331	-.10	.00	-.06	-.18	-.22	-.25	-.21	-.23	-.16	.02
341	.13	.21	.23	.04	-.03	-.08	-.19	-.31	-.40	-.44
351	-.31	-.15	.02	-.04	.02	-.17	-.17	-.07	-.02	-.07
361	-.02	-.05	-.10	-.11	-.14	-.08	.09	.24	.18	.40
371	.42	.34	.20	.05	.16	.22	.16	.13	.04	-.00
381	-.12	-.07	-.07	-.12	-.21	-.07	.07	.16	.16	.12
391	.11	.01	-.09	-.12	-.11	-.07	-.02	.05	.06	.01
401	.00	-1.00	1.12	.00	.04	.00	.00	.00	.00	.02

RMS = 2.822 INCHES

TABLE 25



R027

Figure 31

6/23/79

FORT KNOX STUDY MAY 76 ADDED TO THE DISK ON 24.MAR.77

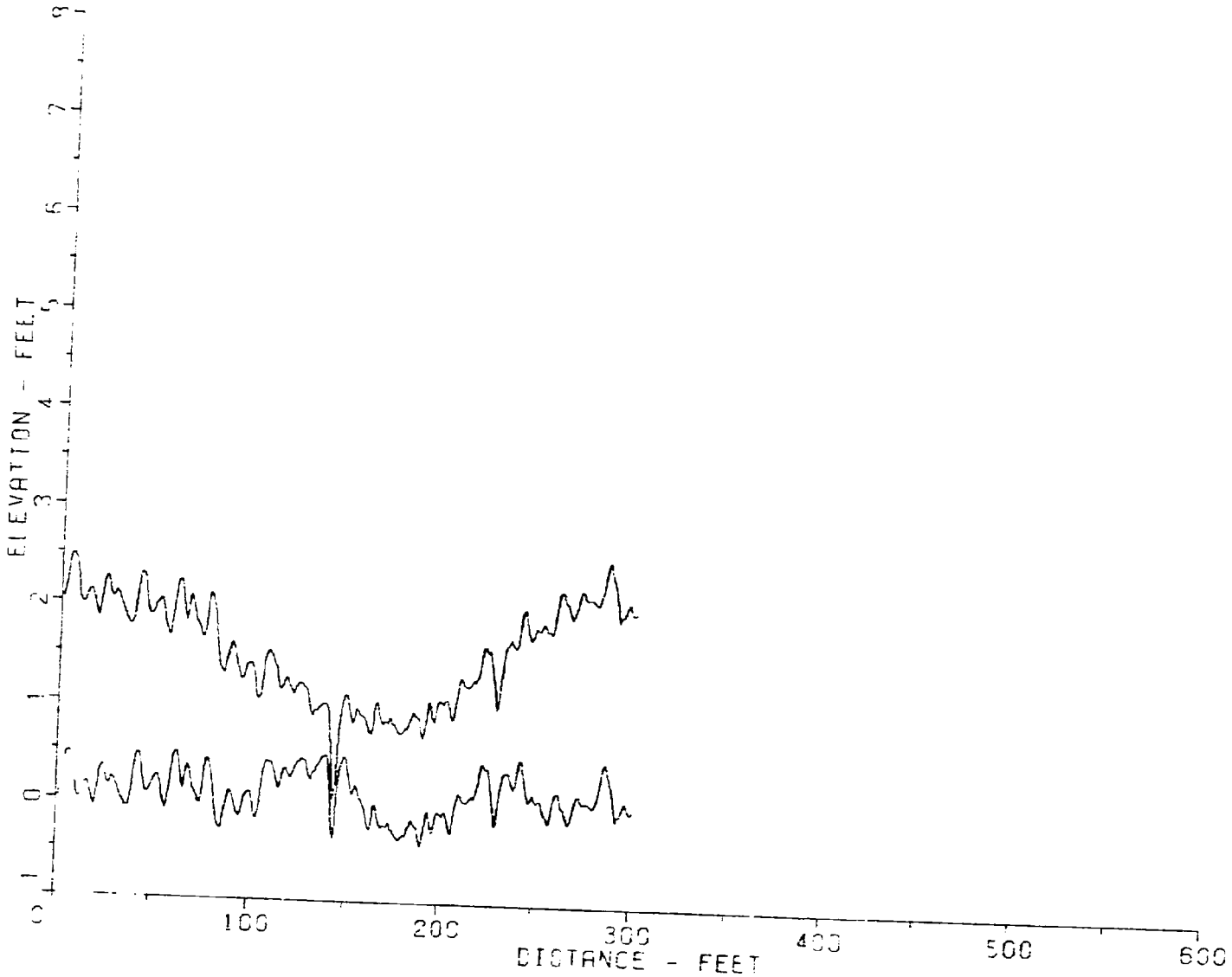
NUMBER OF POINTS = 351

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.02	-.03	-.05	-.08	-.09	-.07	.00	.03	.06
11	.11	.17	.23	.29	.34	.36	.37	.39	.42	.43
21	.44	.43	.41	.41	.39	.37	.33	.31	.28	.25
31	.20	.09	-.00	-.03	-.09	-.17	-.19	-.21	-.34	-.44
41	-.45	-.47	-.41	-.31	-.25	-.22	-.16	-.18	-.16	-.13
51	-.15	-.13	-.12	-.08	-.04	.01	.04	.00	-.01	-.12
61	-.16	-.23	-.34	-.34	-.26	-.25	-.09	-.18	.00	.02
71	.10	.12	.06	-.00	.08	.29	.39	.36	.21	.03
81	-.01	-.01	.01	.01	.06	.05	.09	.15	.18	.18
91	.22	.23	.29	.33	.41	.48	.47	.46	.38	.32
101	.29	.29	.23	.14	.08	.12	.09	.04	.02	.03
111	-.00	.10	.14	.18	.16	.18	.20	.17	.20	.26
121	.22	.24	.22	.20	.17	.16	.02	-.15	-.20	-.17
131	-.14	-.19	-.27	-.32	-.43	-.43	-.36	-.31	-.24	-.14
141	-.01	.13	.25	.36	.38	.28	.15	.02	.03	.01
151	-.05	-.10	-.06	-.11	.01	.08	.13	.18	.22	.29
161	.38	.44	.40	.34	.23	.10	.01	-.06	-.11	-.17
171	-.24	-.32	-.40	-.43	-.41	-.41	-.39	-.36	-.35	-.28
181	-.15	-.13	.02	.04	.13	.19	.28	.35	.44	.49
191	.42	.39	.35	.28	.20	.14	.14	.04	-.05	-.06
201	-.14	-.20	-.26	-.33	-.37	-.39	-.43	-.49	-.46	-.43
211	-.36	-.25	-.24	-.24	-.17	-.11	-.08	-.01	.05	.07
221	.12	.14	.12	.16	.19	.19	.22	.26	.32	.36
231	.38	.39	.38	.40	.41	.38	.30	.19	.03	-.05
241	-.12	-.21	-.26	-.33	-.35	-.36	-.43	-.44	-.45	-.46
251	-.43	-.31	-.18	.01	.14	.31	.40	.46	.47	.39
261	.36	.40	.30	.28	.28	.24	.25	.28	.24	.24
271	.25	.30	.31	.30	.30	.30	.29	.35	.42	.38
281	.34	.34	.29	.19	.03	-.02	-.10	-.15	-.19	-.22
291	-.23	-.28	-.32	-.38	-.40	-.40	-.37	-.29	-.14	.01
301	.23	.09	.28	.07	.11	.16	.33	.25	.15	.11
311	.05	.18	.24	.08	.07	.14	.08	.13	.07	.00
321	-.13	-.19	-.07	.03	.03	-.19	-.32	-.31	-.36	-.33
331	-.39	-.45	-.47	-.46	-.33	-.15	.00	.07	.08	.17
341	.28	.39	.47	.46	.46	.35	.28	.23	.16	.09
351	.01	-1.00	1.12	.00	-.02	-.35	-.34	-.13	-.04	-.18

RMS = 3.135 INCHES

TABLE 26



R028

Figure 32

5/23/78

FLAT N OX STRA MAY 76 ADDED TO THE DISK ON 24,MAR,77

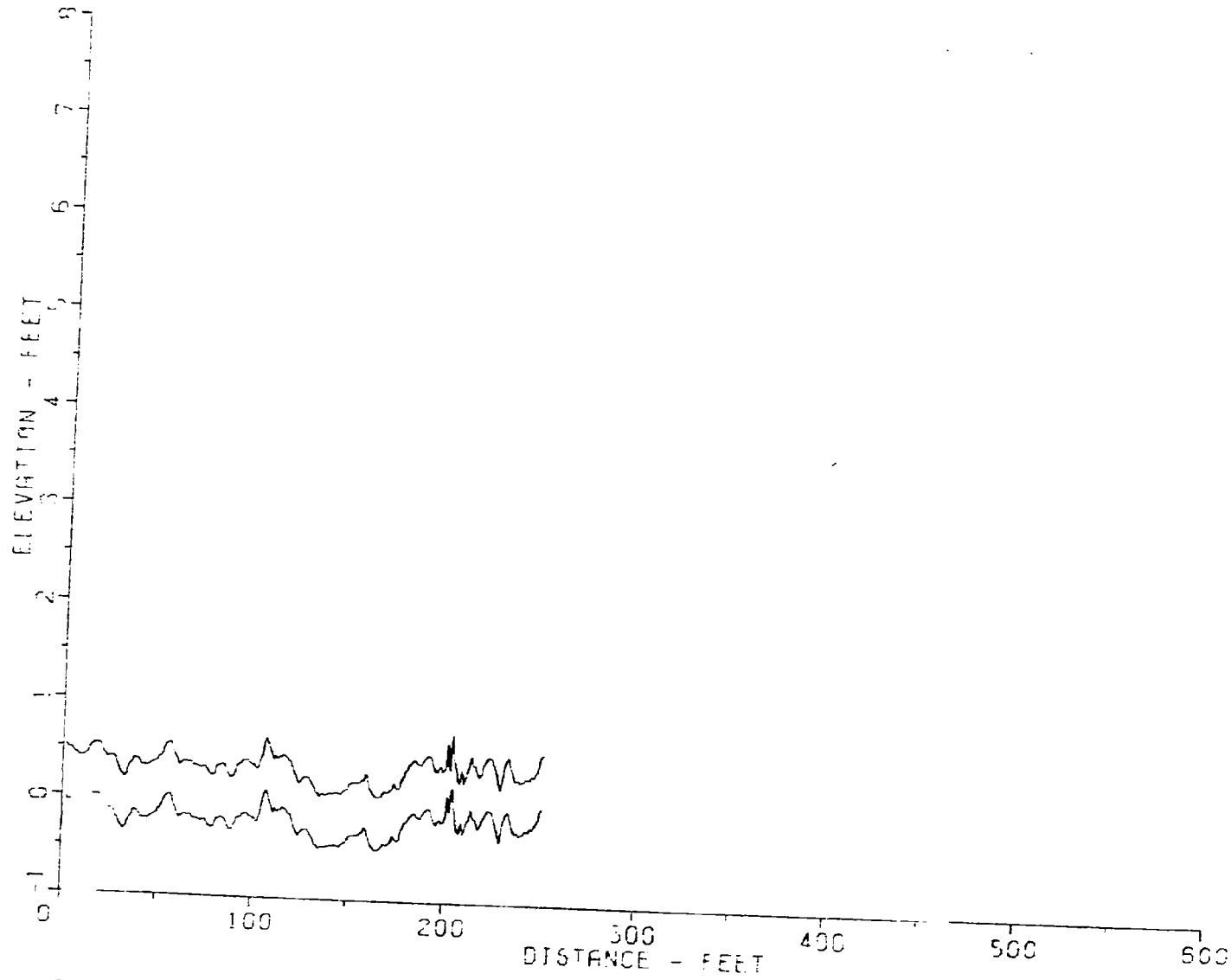
NUMBER OF POINTS = 321

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.18	.21	.35	.47	.48	.46	.42	.28	.08
11	.00	.11	.03	.12	.15	.17	.11	.08	-.04	-.06
21	.02	.16	.31	.34	.30	.19	.14	.17	.21	.16
31	.16	.10	.04	.01	-.04	-.08	-.08	-.06	.04	.22
41	.37	.47	.47	.39	.26	.12	.07	.09	.14	.18
51	.21	.25	.25	.18	.07	-.03	-.10	-.03	.16	.33
61	.46	.50	.49	.35	.19	.12	.26	.37	.33	.23
71	.13	.08	.04	-.02	-.02	.15	.33	.44	.43	.34
81	.22	.04	-.14	-.24	-.27	-.26	-.14	-.04	.07	.16
91	.08	.02	-.05	-.12	-.15	-.11	.01	.07	.10	.12
101	.09	-.02	-.15	-.16	-.07	.11	.29	.40	.43	.41
111	.42	.37	.33	.23	.15	.18	.26	.34	.36	.29
121	.26	.26	.33	.39	.43	.43	.45	.44	.43	.35
131	.26	.25	.32	.33	.39	.42	.46	.49	.50	.48
141	.37	.11	-.28	-.35	-.09	.21	.38	.43	.49	.48
151	.36	.22	.11	.11	.20	.15	.09	.06	.01	-.04
161	-.13	-.21	-.25	-.16	-.01	.00	-.11	-.19	-.24	-.21
171	-.22	-.25	-.17	-.25	-.24	-.30	-.33	-.35	-.36	-.33
181	-.31	-.31	-.25	-.20	-.14	-.18	-.21	-.23	-.31	-.42
191	-.37	-.23	-.06	-.06	-.21	-.27	-.26	-.09	-.06	-.09
201	-.11	-.07	-.07	-.14	-.24	-.28	-.19	-.05	.08	.14
211	.11	.06	.04	.03	.06	.09	.11	.08	.14	.23
221	.33	.43	.43	.38	.39	.33	.16	-.00	-.19	-.13
231	.03	.20	.33	.35	.35	.35	.29	.22	.19	.24
241	.36	.48	.49	.39	.24	.13	.06	.09	.14	.09
251	.04	.08	.08	.01	-.07	-.08	-.14	-.14	-.02	.05
261	.16	.17	.12	.01	-.00	-.06	-.12	-.16	-.12	-.03
271	.04	.14	.14	.09	.05	.07	.06	.06	.05	.02
281	.03	.07	.14	.19	.35	.47	.48	.36	.29	.22
291	.06	-.11	-.07	-.06	-.02	.04	.08	.03	-.03	-.03
301	.00	-1.[illegible]	1.12	.00	.07	.33	.66	.51	.31	.22

RMS = 2.646 INCHES

TABLE 27



RD29

Figure 33

6/23/78

[illegible] 12 NOV 77 ADDED TO THE DISK ON 24.MAR.77

NUMBER OF POINTS = 251

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.[illegible]	-.[illegible]	-.16	-.[illegible]	-.[illegible]	-.10	-.10	-.13	-.14	-.14
11	-.13	-.11	-.09	-.04	-.02	.06	-.00	.00	.01	-.02
21	-.09	-.11	-.15	-.13	-.14	-.12	-.15	-.22	-.25	-.30
31	-.31	-.34	-.31	-.25	-.22	-.19	-.14	-.15	-.15	-.17
41	-.22	-.22	-.21	-.22	-.20	-.19	-.18	-.17	-.16	-.12
51	-.12	-.[illegible]	-.[illegible]	.01	.02	.03	.01	-.05	-.11	-.15
61	-.20	-.18	-.17	-.16	-.18	-.17	-.17	-.20	-.20	-.21
71	-.21	-.22	-.22	-.21	-.22	-.25	-.28	-.29	-.29	-.27
81	-.20	-.20	-.18	-.19	-.19	-.23	-.26	-.31	-.31	-.29
91	-.24	-.18	-.16	-.17	-.14	-.14	-.13	-.16	-.17	-.19
101	-.18	-.23	-.21	-.14	-.06	.05	.10	.05	-.00	-.07
111	-.12	-.[illegible]	-.11	-.09	-.10	-.07	-.09	-.10	-.13	-.15
121	-.20	-.25	-.30	-.36	-.32	-.30	-.29	-.28	-.29	-.31
131	-.35	-.38	-.45	-.46	-.48	-.46	-.46	-.47	-.45	-.45
141	-.45	-.45	-.44	-.44	-.45	-.46	-.43	-.42	-.40	-.38
151	-.34	-.33	-.34	-.33	-.33	-.32	-.30	-.30	-.24	-.20
161	-.37	-.42	-.45	-.48	-.46	-.48	-.47	-.44	-.42	-.43
171	-.42	-.[illegible]	-.36	-.33	-.36	-.39	-.36	-.29	-.24	-.19
181	-.18	-.13	-.12	-.09	-.09	-.12	-.14	-.15	-.17	-.07
191	-.04	-.04	-.06	-.11	-.18	-.20	-.17	-.14	-.19	-.17
201	-.09	.06	-.07	.18	-.01	-.16	-.27	-.29	-.18	-.30
211	-.24	-.18	-.13	-.04	-.12	-.14	-.20	-.24	-.20	-.12
221	-.10	-.05	-.04	-.05	-.08	-.11	-.20	-.31	-.37	-.24
231	-.15	-.[illegible]7	-.[illegible]	-.11	-.19	-.26	-.27	-.26	-.30	-.28
241	-.27	-.25	-.24	-.26	-.22	-.23	-.20	-.15	-.11	-.02
251	.00	-1.[illegible]	1.12	.[illegible]	-.04	-.17	-.29	-.27	-.04	.13

[illegible] = 1.582 INCHES

TABLE 28

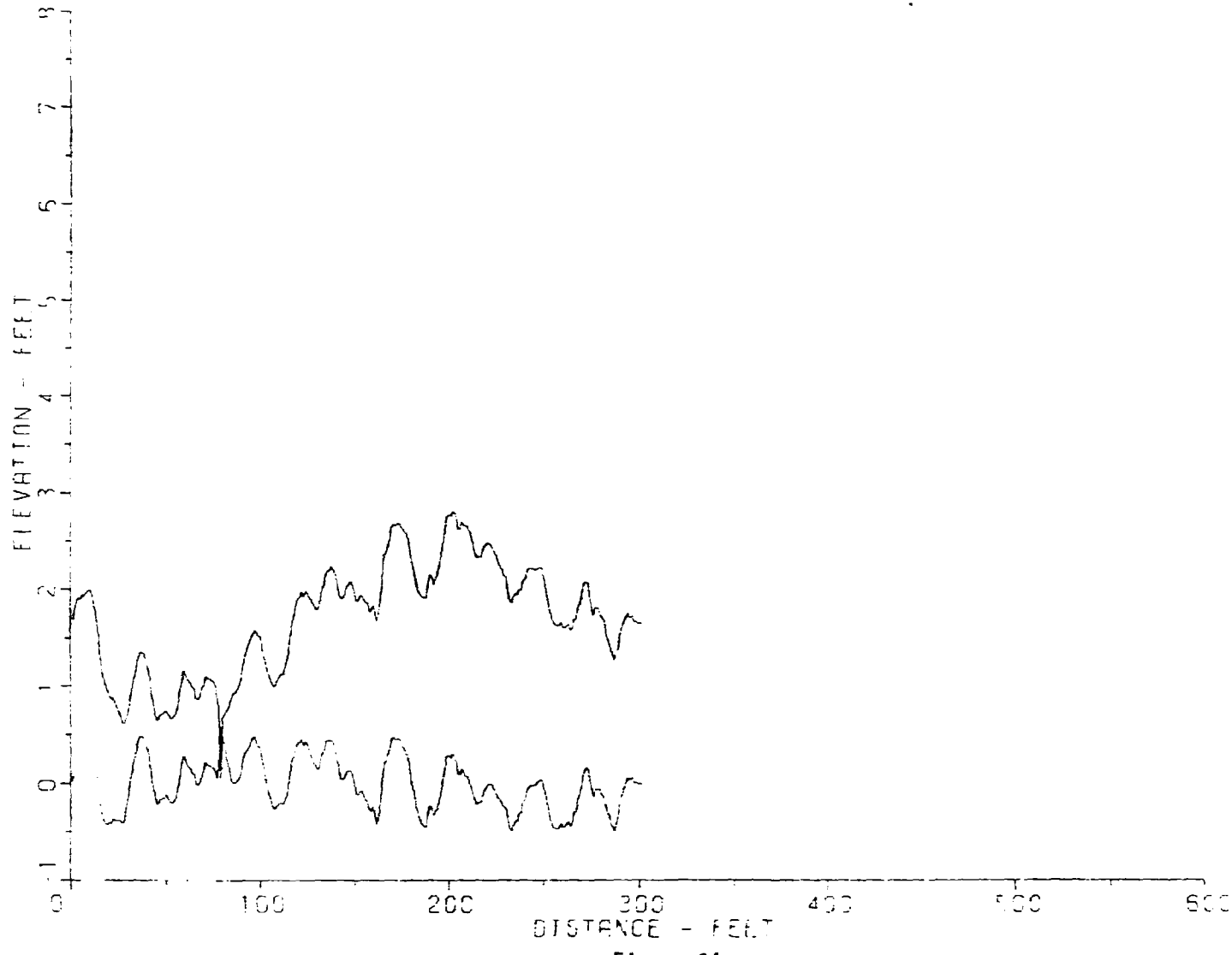


Figure 34

R530

9/23/78

[illegible] 11 NOV 76 ADDED TO THE DISK ON 24-MAR-77

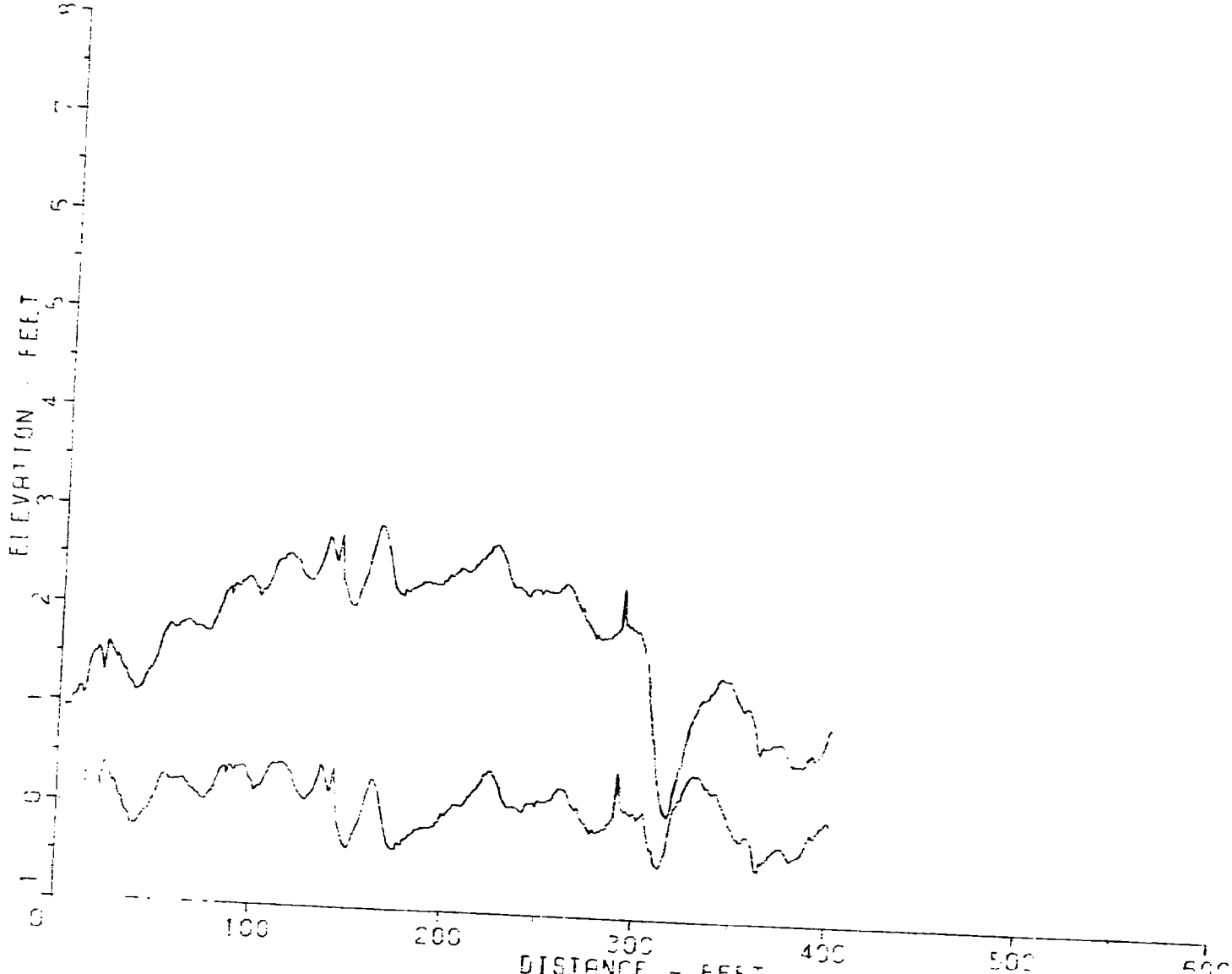
NUMBER OF POINTS = 361

INTERVAL IN INCHES = 12

PLOT	ELEVATIONS IN FEET									
1	.41	.13	.21	-.27	.27	.31	.30	.34	.38	.38
11	.34	.27	.16	.02	-.15	-.31	-.40	-.41	-.44	-.41
21	-.42	-.37	-.36	-.38	-.39	-.39	-.41	-.37	-.26	-.13
31	.11	.13	.24	.29	.44	.48	.49	.47	.42	.34
41	.26	.13	-.03	-.17	-.22	-.21	-.16	-.15	-.13	-.12
51	-.17	-.20	-.21	-.18	-.16	-.06	.03	.15	.28	.28
61	.19	.17	.13	.09	.09	-.01	-.02	.01	.08	.14
71	.21	.19	.19	.16	.15	.10	.05	.24	.20	.40
81	.38	.28	.18	.09	.01	.01	.00	.03	.07	.11
91	.23	.31	.35	.38	.41	.47	.48	.44	.38	.35
101	.25	.12	.05	-.07	-.16	-.21	-.27	-.27	-.23	-.21
111	-.20	-.22	-.18	-.14	-.03	.11	.23	.29	.37	.42
121	.43	.47	.39	.34	.40	.35	.30	.24	.18	.14
131	.16	.23	.31	.36	.44	.45	.45	.46	.40	.33
141	.22	.19	.14	.04	.08	.12	.13	.14	.09	.01
151	-.10	-.11	-.05	-.05	-.14	-.18	-.18	-.26	-.29	-.25
161	-.33	-.41	-.32	-.16	.04	.23	.22	.31	.39	.47
171	.48	.46	.47	.46	.42	.38	.33	.31	.21	.10
181	-.23	-.13	-.24	-.34	-.35	-.42	-.44	-.44	-.32	-.23
191	-.24	-.30	-.28	-.27	-.18	-.06	.03	.15	.28	.29
201	.26	.31	.27	.22	.10	.06	.15	.10	.07	.08
211	.01	-.04	-.11	-.18	-.22	-.20	-.20	-.12	-.08	-.01
221	-.01	-.01	-.03	-.07	-.11	-.15	-.18	-.21	-.25	-.27
231	-.35	-.46	-.49	-.43	-.37	-.37	-.31	-.30	-.21	-.17
241	-.06	-.14	-.02	-.01	-.02	-.00	.02	.04	.04	-.02
251	-.12	-.24	-.34	-.41	-.45	-.47	-.47	-.45	-.41	-.44
261	-.44	-.40	-.39	-.44	-.38	-.30	-.27	-.16	-.09	.00
271	.12	.16	.14	.05	-.07	-.14	-.06	-.06	-.05	-.11
281	-.13	-.20	-.30	-.33	-.40	-.46	-.49	-.39	-.30	-.18
291	-.05	-.01	.02	.07	.04	.07	.00	.01	-.00	-.00
301	.00	-1.00	1.12	.00	.13	.33	.66	.51	.31	.22

RMS = 3.215 INCHES

TABLE 29



R031

Figure 35

9/23/79

AF-34 11 NOV 76 ADDED TO THE DISK ON 24-MAR-77

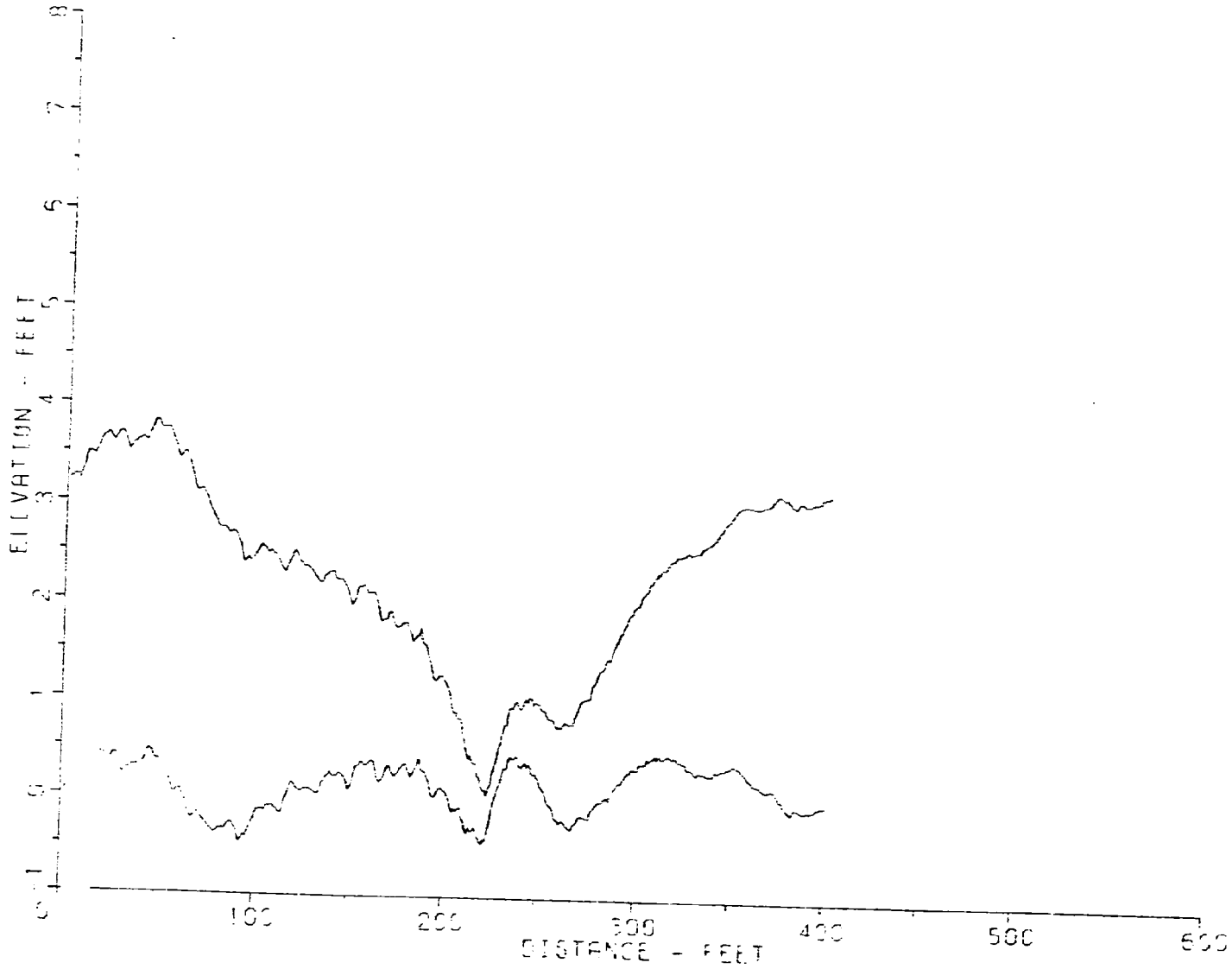
NUMBER OF POINTS = 441

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.11	-.17	-.06	-.04	-.08	.00	-.01	.03	.07
11	.05	-.03	.03	.15	.27	.33	.36	.36	.36	.36
21	.28	.14	.27	.40	.35	.30	.24	.19	.22	.17
31	.11	.15	.22	-.03	-.10	-.12	-.15	-.22	-.22	-.23
41	-.21	-.19	-.15	-.11	-.09	-.07	-.06	-.02	.03	.07
51	.15	.23	.24	.28	.30	.27	.24	.24	.23	.25
61	.26	.25	.25	.26	.25	.21	.20	.16	.15	.14
71	.12	.11	.08	.08	.05	.05	.07	.12	.14	.18
81	.23	.27	.33	.37	.39	.40	.31	.41	.39	.36
91	.37	.40	.40	.41	.41	.40	.37	.32	.27	.22
101	.16	.17	.21	.24	.23	.26	.31	.36	.41	.44
111	.45	.44	.44	.45	.46	.46	.44	.41	.38	.36
121	.34	.26	.19	.16	.14	.11	.09	.03	.10	.12
131	.16	.20	.23	.26	.33	.45	.41	.36	.27	.18
141	.18	.35	.41	.12	-.12	-.19	-.26	-.32	-.36	-.39
151	-.39	-.34	-.28	-.24	-.19	-.13	-.10	-.02	.08	.14
161	.22	.28	.32	.30	.25	.18	.12	.01	-.09	-.17
171	-.27	-.33	-.36	-.38	-.38	-.39	-.32	-.33	-.33	-.29
181	-.27	-.26	-.24	-.22	-.21	-.18	-.17	-.17	-.15	-.18
191	-.15	-.15	-.16	-.14	-.14	-.14	-.09	-.08	-.04	-.01
201	-.03	.01	.03	.06	.09	.09	.10	.08	.08	.09
211	.11	.13	.17	.19	.22	.25	.27	.31	.33	.36
221	.41	.42	.44	.45	.42	.39	.36	.31	.28	.24
231	.16	.12	.09	.09	.10	.10	.09	.08	.07	.05
241	.04	.07	.12	.13	.14	.14	.15	.10	.16	.16
251	.16	.15	.16	.16	.18	.18	.20	.24	.27	.30
261	.31	.29	.29	.27	.21	.17	.13	.11	.08	.12
271	.03	-.01	-.03	-.04	-.08	-.12	-.14	-.10	-.13	-.14
281	-.11	-.13	-.10	-.10	-.09	-.04	-.03	.00	.04	.22
291	.08	.22	.11	.08	.10	.07	.08	.05	.06	.04
301	.00	-.04	-.06	-.09	-.03	-.09	-.20	-.29	-.28	-.42
311	-.44	-.48	-.48	-.44	-.37	-.28	-.18	.00	.06	.15
321	.18	.23	.23	.31	.36	.39	.43	.46	.49	.48
331	.47	.45	.46	.42	.39	.35	.36	.32	.30	.31
341	.31	.30	.26	.20	.16	.12	.06	.00	-.03	-.05
351	-.10	-.14	-.15	-.17	-.17	-.13	-.11	-.12	-.15	-.20
361	-.28	-.38	-.46	-.47	-.37	-.39	-.36	-.36	-.32	-.29
371	-.26	-.25	-.24	-.21	-.22	-.21	-.26	-.27	-.31	-.38
381	-.35	-.33	-.31	-.30	-.30	-.29	-.25	-.20	-.14	-.11
391	-.07	-.11	-.09	-.06	-.03	.00	.00	.02	.06	.06
401	.00	-1.00	1.12	.00	-.01	.00	.00	.00	.00	.00

RMS = 2.853 INCHES

TABLE 30



RD32

Figure 36

5/23/79

AP,3S 11 NOV 76 ADDED TO THE DISK ON 24.MAR.77

NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.[illegible]	.[illegible]	.07	.06	.05	.01	.00	.15	.23
11	.27	.26	.25	.23	.26	.28	.35	.39	.41	.42
21	.43	.41	.37	.33	.37	.38	.41	.42	.39	.34
31	.28	.21	.24	.27	.28	.30	.30	.31	.31	.29
41	.27	.31	.37	.42	.47	.46	.45	.38	.36	.37
51	.37	.36	.34	.29	.24	.17	.07	.03	.03	.07
61	.07	.[illegible]	.[illegible]	-.05	-.12	-.18	-.23	-.23	-.20	-.17
71	-.17	-.18	-.22	-.26	-.28	-.30	-.33	-.35	-.37	-.37
81	-.36	-.33	-.33	-.32	-.34	-.30	-.28	-.26	-.28	-.31
91	-.35	-.40	-.46	-.43	-.38	-.40	-.37	-.32	-.26	-.21
101	-.18	-.12	-.12	-.12	-.14	-.12	-.07	-.10	-.08	-.08
111	-.10	-.12	-.15	-.16	-.13	-.07	.00	.07	.13	.16
121	.14	.1[illegible]	.[illegible]	.07	.07	.09	.10	.09	.10	.08
131	.06	.05	.04	.06	.09	.16	.19	.22	.25	.20
141	.23	.22	.23	.23	.27	.25	.23	.21	.16	.08
151	.12	.18	.28	.33	.35	.38	.38	.35	.34	.37
161	.39	.3[illegible]	.38	.31	.22	.16	.19	.22	.24	.31
171	.35	.32	.27	.23	.25	.28	.32	.33	.36	.37
181	.31	.27	.23	.28	.32	.34	.43	.31	.30	.28
191	.24	.19	.12	.03	.02	.06	.10	.12	.12	.09
201	.08	.07	.00	-.04	-.12	-.08	-.12	-.09	-.07	-.17
211	-.22	-.28	-.34	-.28	-.32	-.30	-.28	-.35	-.39	-.44
221	-.44	-.39	-.41	-.31	-.21	-.10	.01	.08	.15	.18
231	.25	.3[illegible]	.33	.41	.46	.43	.44	.47	.44	.36
241	.34	.36	.40	.34	.30	.38	.27	.28	.24	.23
251	.15	.12	.09	.02	-.02	-.04	-.07	-.12	-.19	-.19
261	-.22	-.20	-.19	-.22	-.26	-.27	-.29	-.26	-.22	-.20
271	-.15	-.14	-.15	-.16	-.17	-.17	-.09	-.06	-.06	-.01
281	.01	.[illegible]	.01	.04	.08	.02	.06	.11	.15	.16
291	.21	.2[illegible]	.23	.26	.29	.31	.31	.35	.36	.33
301	.35	.4[illegible]	.40	.40	.41	.46	.43	.46	.47	.49
311	.45	.4[illegible]	.46	.46	.48	.49	.49	.47	.47	.48
321	.46	.44	.44	.42	.42	.41	.36	.36	.35	.34
331	.31	.3[illegible]	.33	.32	.31	.31	.30	.30	.30	.29
341	.31	.34	.32	.34	.36	.36	.36	.37	.38	.39
351	.40	.4[illegible]	.39	.38	.37	.35	.32	.30	.27	.25
361	.23	.21	.20	.19	.19	.17	.16	.15	.14	.15
371	.16	.16	.15	.12	.09	.05	.05	.00	-.01	-.03
381	-.06	-.[illegible]	-.07	-.03	-.03	-.03	-.06	-.06	-.07	-.06
391	-.05	-.[illegible]	-.06	-.05	-.04	-.02	-.02	.00	-.02	.00
401	.00	-1.[illegible]	1.12	.00	.05	.00	.00	.00	.00	.00

RMS = 2.040 INCHES

TABLE 31

Figure 37

AP-37 13 NOV 77 ADDED TO THE DISK ON 24.MAR.77

NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.06	.12	-.03	-.04	-.03	-.06	-.11	-.11	-.13	-.15
11	-.15	-.17	-.18	-.13	-.12	-.08	-.04	-.01	.04	.10
21	.15	.17	.21	.27	.28	.28	.31	.32	.33	.33
31	.30	.26	.39	.30	.26	.22	.20	.16	.16	.16
41	.14	.12	.13	.11	.11	.08	.04	.02	.02	-.01
51	-.01	.02	.01	-.02	-.00	-.01	.03	.08	.06	.08
61	.11	.12	.15	.19	.20	.20	.24	.26	.26	.26
71	.26	.26	.28	.29	.32	.28	.28	.30	.30	.29
81	.28	.26	.22	.22	.22	.19	.18	.19	.18	.21
91	.21	.18	.20	.23	.21	.20	.23	.22	.23	.20
101	.29	.33	.38	.43	.44	.46	.44	.43	.44	.46
111	.45	.46	.47	.45	.44	.45	.46	.44	.46	.48
121	.45	.43	.47	.43	.44	.45	.43	.40	.40	.38
131	.34	.34	.34	.31	.31	.31	.29	.24	.25	.19
141	.18	.22	.17	.11	.12	.11	.08	.12	.12	.09
151	.08	.09	.04	.04	.04	.02	-.01	.01	.02	.04
161	.04	-.00	-.02	-.00	.00	-.01	-.01	.01	.00	-.01
171	-.01	-.01	-.03	-.04	-.01	.01	.01	.02	.02	.02
181	.04	.02	.02	.04	.04	.01	.02	.05	.03	.05
191	.03	-.04	-.07	-.07	-.10	-.13	-.12	-.14	-.16	-.19
201	-.19	-.15	-.13	-.14	-.11	-.09	-.07	-.04	-.02	.04
211	.06	.11	.18	.19	.19	.21	.23	.24	.21	.23
221	.22	.22	.23	.24	.22	.22	.19	.19	.18	.14
231	.10	.12	.08	.09	.12	.08	.08	.11	.12	.12
241	.13	.13	.12	.14	.16	.14	.12	.14	.09	.11
251	.09	.09	.08	.08	.08	.07	.05	.04	.01	.01
261	.01	-.01	-.03	-.02	-.04	-.04	-.03	-.06	-.07	-.07
271	-.06	-.09	-.08	-.10	-.11	-.14	-.14	-.18	-.17	-.18
281	-.16	-.15	-.16	-.15	-.13	-.08	-.07	-.07	-.08	-.07
291	-.09	-.09	-.11	-.08	-.12	-.13	-.10	-.11	-.13	-.09
301	-.10	-.13	-.09	-.11	-.12	-.12	-.13	-.16	-.14	-.17
311	-.24	-.25	-.22	-.22	-.25	-.24	-.23	-.23	-.24	-.25
321	-.22	-.25	-.24	-.23	-.22	-.24	-.22	-.19	-.18	-.16
331	-.17	-.16	-.16	-.16	-.16	-.14	-.17	-.16	-.13	-.12
341	-.09	-.13	-.11	-.09	-.10	-.08	-.11	-.10	-.08	-.10
351	-.09	-.08	-.07	-.07	-.06	-.07	-.08	-.08	-.07	-.11
361	-.13	-.14	-.20	-.20	-.23	-.23	-.25	-.24	-.27	-.30
371	-.25	-.24	-.23	-.22	-.22	-.25	-.26	-.26	-.33	-.31
381	-.28	-.25	-.23	-.17	-.16	-.09	-.04	-.01	.04	.00
391	.08	.05	.06	.04	.03	.01	.01	-.01	-.00	-.01
401	.00	-1.00	1.12	.02	.02	.00	.00	.00	.00	.00

RMS = 2.292 INCHES

TABLE 32

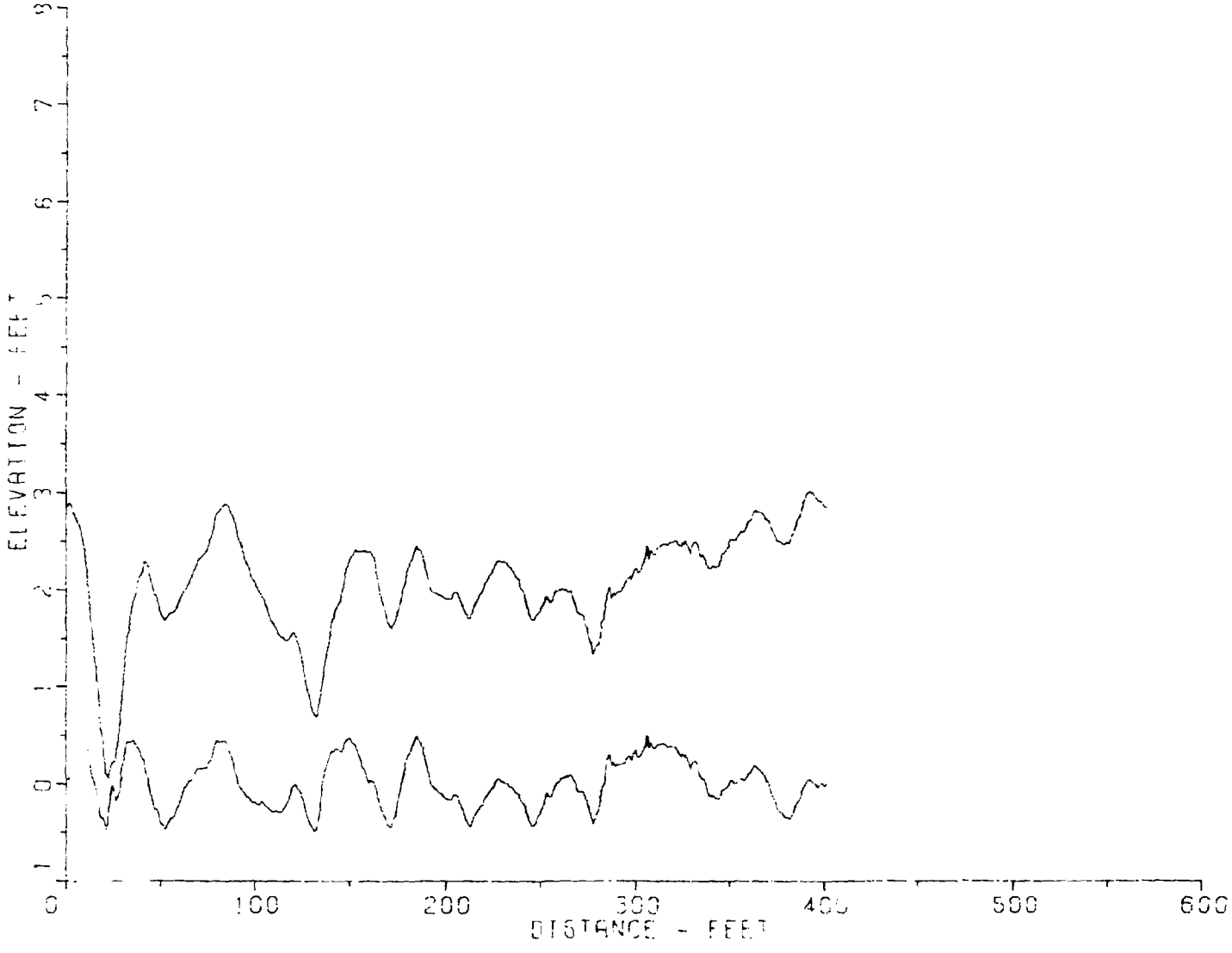


Figure 38

R034

9/23/79

SE-32 1* NOV 75 ADDED TO THE DISK ON 24.MAR.77

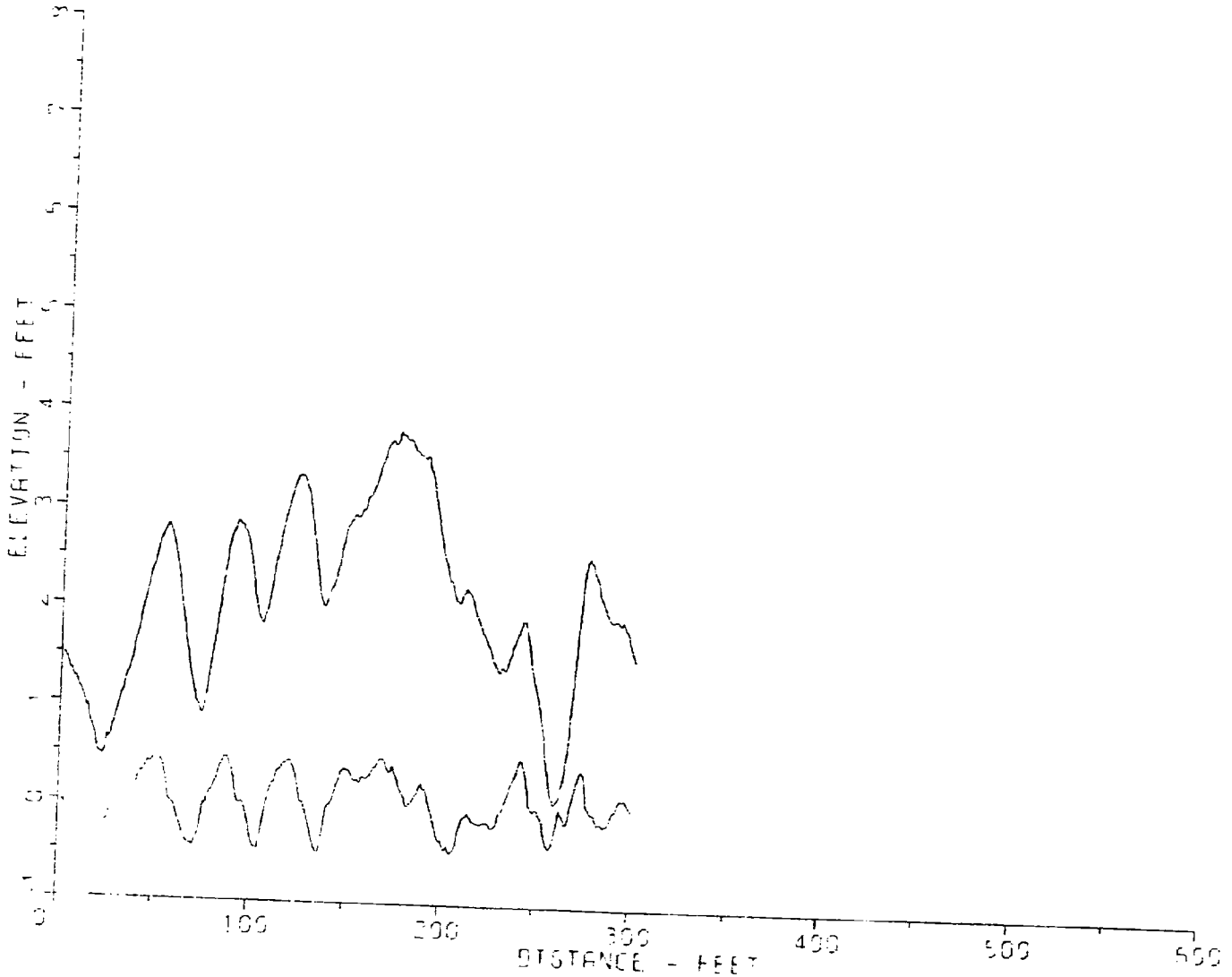
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.02	.15	.21	.26	.31	.37	.44	.48	.50	.49
11	.40	.31	.18	.22	-.01	-.11	-.17	-.36	-.35	-.39
21	-.46	-.38	-.19	.00	-.09	-.18	-.13	-.07	.10	.24
31	.32	.44	.43	.44	.47	.41	.38	.36	.32	.25
41	.25	.15	.02	-.10	-.14	-.22	-.27	-.27	-.38	-.42
51	-.43	[illegible]	-.44	-.39	-.36	-.35	-.32	-.30	-.24	-.18
61	-.14	[illegible]	-.03	[illegible]	.13	.04	.07	.09	.12	.15
71	.16	.16	.16	.16	.17	.24	.26	.31	.38	.45
81	.43	.45	.44	.44	.43	.36	.32	.26	.20	.11
91	.01	-.03	-.06	-.09	-.11	-.15	-.16	-.18	-.21	-.19
101	-.21	-.22	-.21	-.19	-.21	-.23	-.26	-.27	-.29	-.29
111	-.28	-.29	-.30	-.29	-.26	-.25	-.21	-.16	-.10	-.03
121	-.01	-.02	-.05	-.10	-.15	-.20	-.28	-.35	-.41	-.44
131	-.49	-.45	-.46	-.31	-.14	.02	.15	.16	.23	.33
141	.33	.35	.36	.35	.33	.33	.37	.43	.46	.48
151	.45	.41	.41	.34	.28	.24	.17	.12	.05	.00
161	.03	.02	-.20	-.26	-.16	-.24	-.30	-.33	-.36	-.43
171	-.45	-.47	-.37	-.41	-.21	-.11	.01	.09	.16	.23
181	.31	.37	.41	.44	.50	.45	.43	.37	.29	.20
191	.12	.01	-.04	-.05	-.07	-.09	-.11	-.12	-.15	-.16
201	-.17	-.17	-.17	-.12	-.12	-.14	-.18	-.24	-.29	-.35
211	-.40	-.44	-.44	-.39	-.33	-.29	-.26	-.23	-.21	-.17
221	-.13	-.11	-.07	-.04	-.02	.03	.05	.05	.02	.03
231	.00	.00	-.03	-.03	-.06	-.06	-.10	-.11	-.17	-.21
241	-.22	-.28	-.35	-.41	-.44	-.43	-.40	-.34	-.31	-.26
251	-.22	-.16	-.10	-.14	-.14	-.10	-.02	.01	.03	.03
261	.06	.05	.08	.08	.09	.00	.03	-.00	-.08	-.09
271	-.09	-.09	-.15	-.19	-.27	-.34	-.42	-.36	-.32	-.28
281	-.17	-.03	.01	.13	.25	.30	.19	.22	.17	.20
291	[illegible]	[illegible]	.21	.22	.25	.28	.29	.24	.30	.34
301	.27	.28	.30	.34	.40	.50	.36	.43	.37	.35
311	.40	.41	.47	.42	.41	.39	.37	.39	.38	.38
321	.37	.38	.30	.27	.30	.28	.31	.22	.15	.21
331	.23	.23	.10	.08	.04	.05	-.01	-.07	-.13	-.14
341	-.12	-.15	-.15	-.16	-.12	-.06	-.06	-.05	-.02	.03
351	.04	.01	-.02	.02	.04	.05	.03	.05	.07	.11
361	.12	.15	.19	.17	.15	.14	.12	.08	.02	.02
371	-.04	-.10	-.16	-.21	-.26	-.28	-.31	-.34	-.35	-.34
381	-.37	-.34	-.31	-.28	-.21	-.18	-.14	-.07	-.02	.01
391	.04	.05	.21	.00	-.01	-.04	-.03	-.00	.01	-.03
401	.00	-1.00	1.12	.00	.15	.00	.00	.00	.00	.00

RMS = 3.087 INCHES

TABLE 33



R035

Figure 39

5/27/83

AT 34 16 NOV 76 ADDED TO THE DISK ON 24.MAR.77

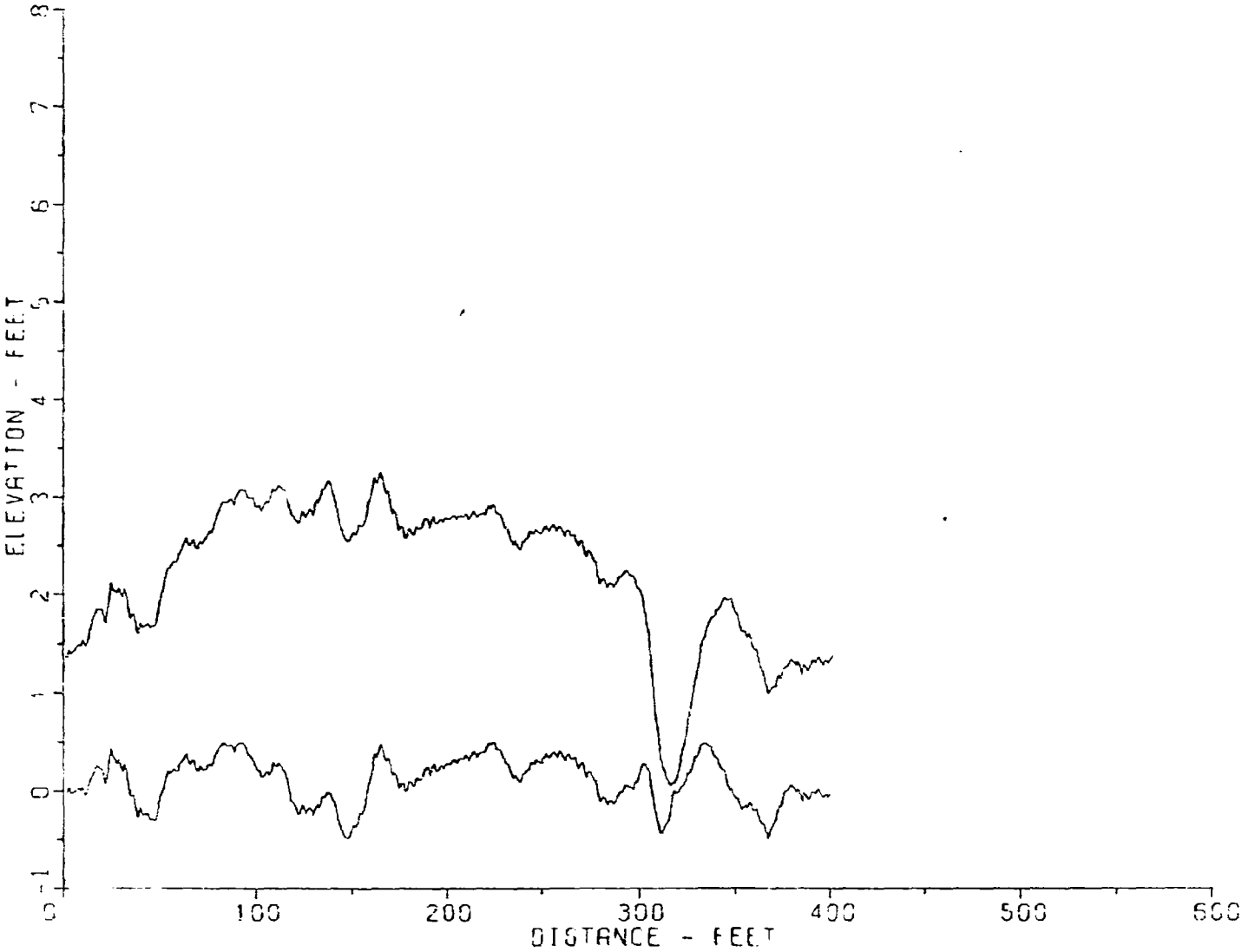
NUMBER OF POINTS = 341

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.02	-.03	-.05	-.06	-.07	-.11	-.09	-.12	-.14
11	-.13	-.15	-.18	-.23	-.17	-.20	-.33	-.34	-.38	-.46
21	-.49	-.47	-.46	-.34	-.21	-.20	-.12	.00	-.00	.01
31	.01	.05	.04	.05	.07	.06	.06	.08	.12	.15
41	.20	.25	.30	.32	.32	.39	.41	.40	.42	.44
51	.46	.04	.02	.00	.36	.26	.14	.01	.00	-.03
61	-.04	-.12	-.17	-.21	-.31	-.33	-.35	-.41	-.43	-.42
71	-.45	-.44	-.34	-.31	-.16	.00	-.02	.05	.09	.12
81	.17	.21	.25	.31	.38	.42	.46	.47	.43	.37
91	.34	.25	.12	.01	.00	.02	.00	-.05	-.13	-.21
101	-.33	-.42	-.44	-.46	-.46	-.37	-.25	-.12	.00	.00
111	.14	.22	.23	.31	.34	.35	.37	.41	.42	.44
121	.45	.43	.36	.31	.25	.15	.02	.02	-.03	-.08
131	-.16	-.24	-.31	-.42	-.46	-.48	-.47	-.38	-.24	-.10
141	.00	.01	.02	.08	.15	.23	.28	.34	.37	.37
151	.35	.36	.31	.27	.25	.27	.23	.24	.30	.28
161	.28	.30	.31	.36	.39	.40	.42	.48	.48	.47
171	.45	.38	.34	.35	.40	.33	.28	.22	.16	.13
181	.09	.01	-.04	.03	.05	.09	.12	.14	.21	.24
191	.18	.18	.12	.04	-.03	-.09	-.16	-.23	-.30	-.36
201	-.34	-.36	-.43	-.40	-.42	-.48	-.45	-.43	-.36	-.28
211	-.18	-.11	-.10	-.08	-.05	-.09	-.14	-.13	-.16	-.18
221	-.16	-.15	-.14	-.15	-.15	-.16	-.20	-.19	-.17	-.15
231	-.05	-.04	.00	.04	.12	.17	.25	.29	.33	.37
241	.45	.45	.48	.44	.33	.19	.03	.00	-.03	-.00
251	-.02	-.07	-.08	-.13	-.26	-.33	-.38	-.40	-.37	-.33
261	-.21	-.14	.00	-.05	-.05	-.14	-.13	-.06	.06	.16
271	.23	.31	.39	.40	.35	.22	.04	.01	-.03	-.04
281	-.04	-.11	-.14	-.13	-.14	-.17	-.15	-.14	-.10	-.05
291	-.11	.01	.04	.11	.11	.14	.11	.07	.04	.01
301	.00	-1.00	1.80	.00	-.02	.00	.00	.00	.00	.00

RMS = 3.163 INCHES

TABLE 34



RD36

Figure 40

6/27/79

RC36

APR34 18 NOV 76 ADDED TO THE DISK ON 24.MAR.77

NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.13	.03	-.08	-.01	-.21	.01	.02	-.01	.04
11	-.02	-.05	.01	.12	.15	.20	.23	.25	.23	.22
21	.18	.07	.16	.30	.43	.34	.31	.28	.31	.25
31	.20	.27	.17	.07	-.06	-.04	-.05	-.21	-.27	-.18
41	-.23	-.24	-.24	-.25	-.30	-.29	-.30	-.30	-.21	-.11
51	-.02	.03	.12	.20	.18	.20	.23	.21	.20	.27
61	.29	.32	.34	.37	.29	.27	.31	.30	.21	.20
71	.25	.21	.23	.23	.26	.26	.28	.20	.35	.41
81	.44	.46	.49	.48	.45	.46	.47	.45	.39	.46
91	.49	.49	.49	.47	.44	.37	.35	.34	.31	.23
101	.21	.22	.15	.15	.19	.20	.17	.22	.29	.26
111	.25	.26	.26	.22	.19	.17	.08	-.04	-.12	-.14
121	-.19	-.24	-.23	-.14	-.16	-.22	-.20	-.17	-.20	-.25
131	-.18	-.13	-.17	-.12	-.05	-.06	-.02	.00	-.03	-.10
141	-.12	-.19	-.29	-.37	-.41	-.46	-.48	-.49	-.46	-.41
151	-.35	-.37	-.32	-.23	-.23	-.20	-.14	-.02	.08	.14
161	.28	.37	.34	.40	.47	.44	.36	.31	.34	.30
171	.16	.19	.17	.10	.02	.07	.07	-.01	.01	.09
181	.09	.04	.25	.13	.11	.12	.14	.23	.24	.23
191	.18	.24	.27	.20	.21	.26	.25	.23	.27	.27
201	.27	.25	.30	.32	.28	.32	.33	.32	.34	.36
211	.34	.30	.36	.40	.38	.34	.38	.38	.40	.36
221	.44	.48	.46	.50	.49	.43	.42	.41	.36	.32
231	.28	.28	.21	.17	.13	.16	.13	.08	.09	.17
241	.18	.21	.22	.29	.26	.27	.32	.30	.28	.29
251	.34	.37	.35	.32	.37	.39	.36	.33	.39	.39
261	.34	.31	.36	.37	.32	.32	.34	.28	.23	.28
271	.20	.18	.13	.20	.18	.13	.10	.10	-.02	-.12
281	-.08	-.07	-.11	-.15	-.10	-.11	-.14	-.10	-.06	-.02
291	-.01	.02	.05	.06	.03	.02	.01	.08	.10	.17
301	.24	.28	.27	.22	.21	.06	-.05	-.18	-.28	-.36
311	-.43	-.44	-.37	-.34	-.29	-.21	-.08	.00	-.02	-.02
321	.02	.04	.07	.12	.19	.18	.24	.36	.36	.36
331	.39	.46	.48	.48	.47	.45	.45	.40	.34	.33
341	.27	.24	.22	.20	.13	.05	.00	.01	-.05	-.08
351	-.08	-.14	-.20	-.18	-.15	-.18	-.12	-.14	-.20	-.21
361	-.18	-.26	-.32	-.34	-.34	-.42	-.49	-.42	-.37	-.34
371	-.00	-.20	-.15	-.16	-.07	.00	-.00	.01	.07	.03
381	.02	-.02	.02	-.03	-.11	-.02	-.06	-.10	-.07	-.02
391	-.01	-.04	-.00	.02	-.04	-.08	-.04	-.05	-.05	-.05
401	.00	-1.20	1.80	.00	-.03	.00	.00	.00	.00	.00

RMS = 2.851 INCHES

TABLE 35

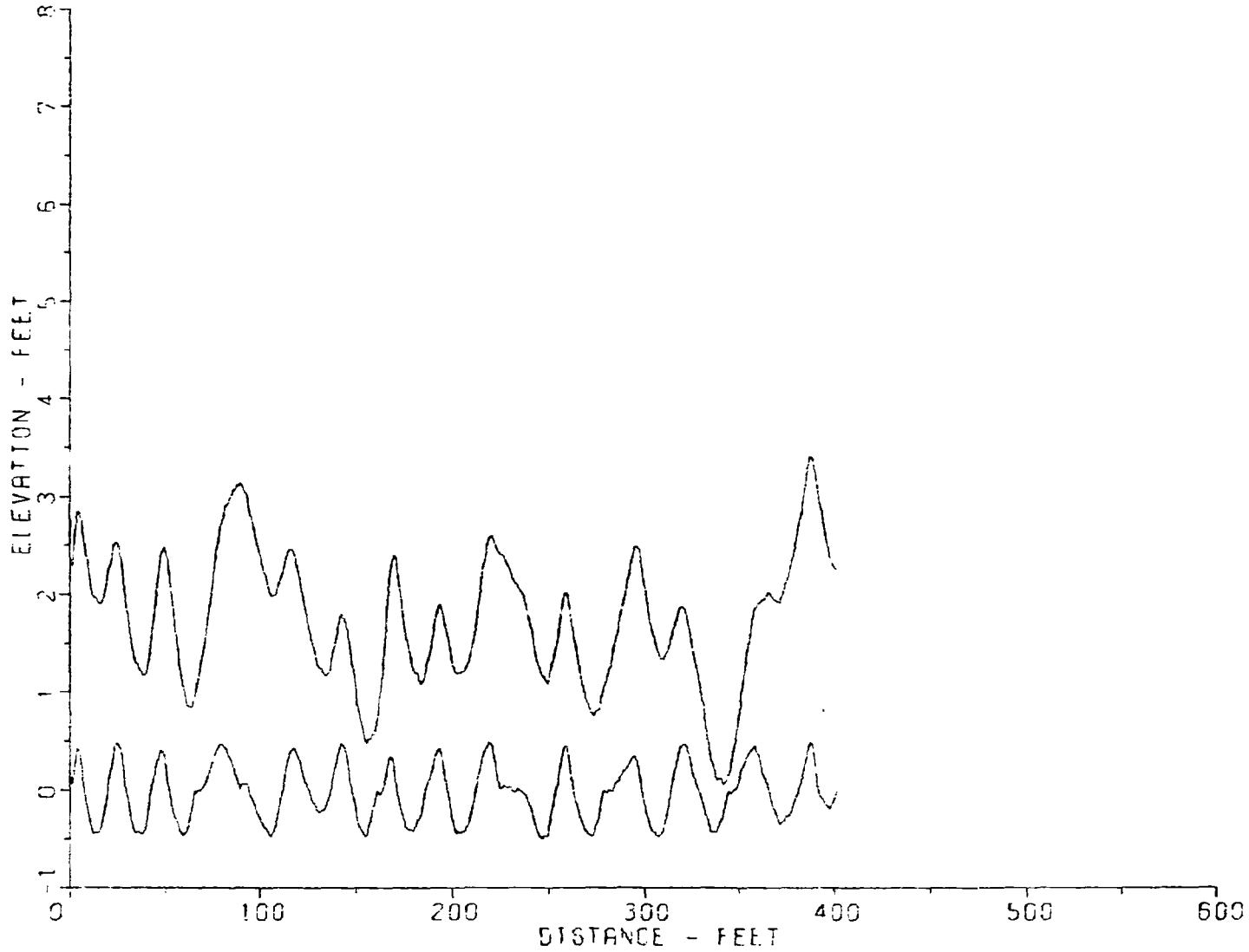


Figure 41

R037

6/27/78

APG31 16 NOV 76 ADDED TO THE DISK ON 24-MAR-77

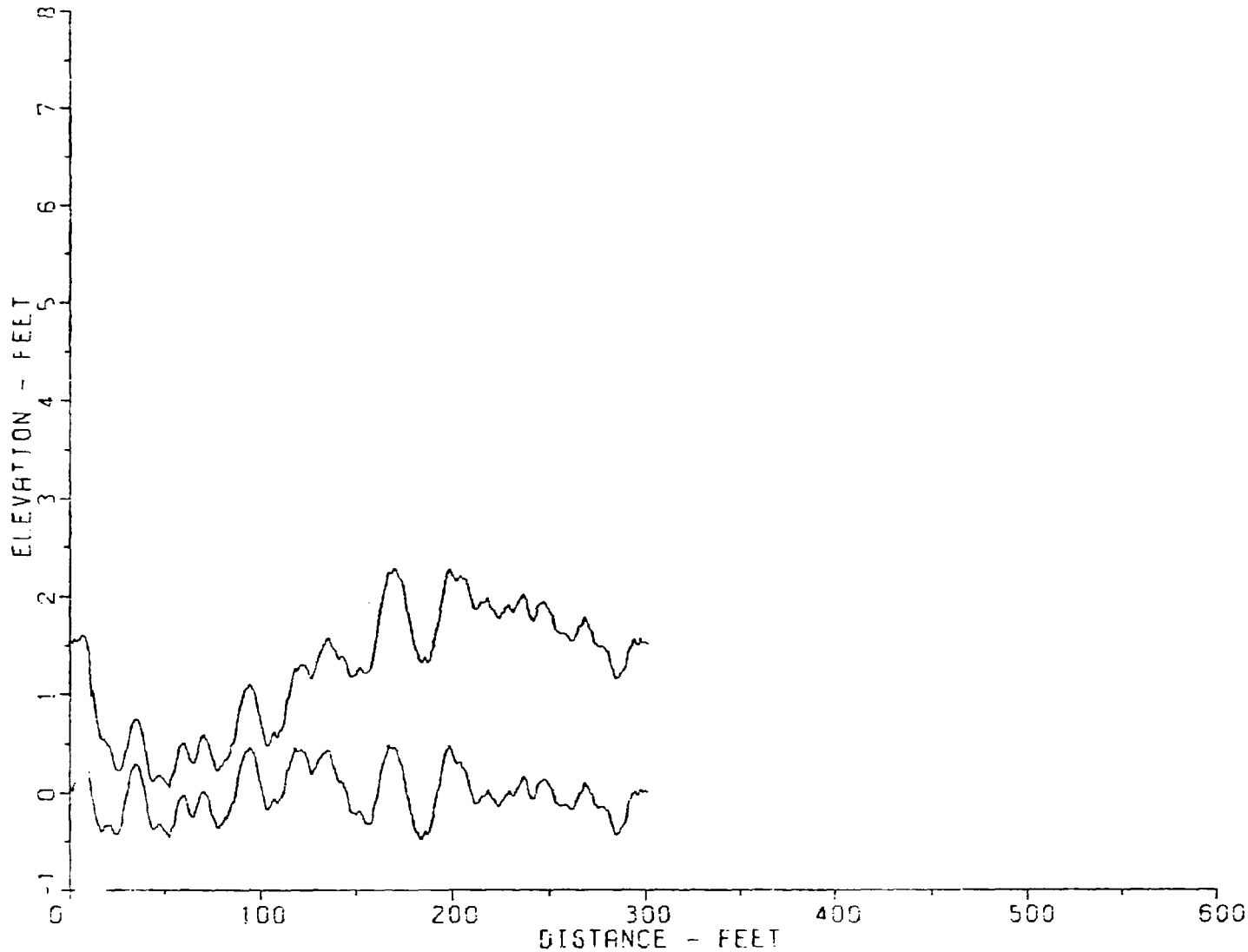
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.02	.19	.35	.43	.38	.23	.04	-.10	-.19	-.27
11	-.39	-.45	-.44	-.44	-.43	-.39	-.29	-.21	-.09	.00
21	.19	.30	.43	.48	.48	.42	.33	.16	-.01	-.16
31	-.20	-.33	-.42	-.45	-.42	-.45	-.45	-.45	-.41	-.33
41	-.15	.02	.26	.16	.28	.34	.41	.39	.36	.23
51	.04	-.06	-.15	-.23	-.25	-.33	-.40	-.44	-.47	-.44
61	-.43	-.47	-.28	-.16	.00	-.04	.00	-.00	.02	.05
71	.06	.12	.19	.24	.30	.37	.41	.45	.48	.46
81	.43	.42	.35	.32	.27	.23	.15	.10	.01	.00
91	.06	.05	.06	-.01	-.07	-.10	-.16	-.22	-.25	-.29
101	-.34	-.36	-.38	-.43	-.47	-.48	-.42	-.36	-.28	-.18
111	-.09	.02	.15	.25	.34	.39	.42	.44	.39	.33
121	.28	.23	.13	.07	.02	-.04	-.10	-.13	-.16	-.21
131	-.23	-.21	-.20	-.19	-.15	-.08	.01	.09	.19	.29
141	.39	.46	.48	.43	.36	.28	.14	.01	-.10	-.18
151	-.31	-.38	-.42	-.45	-.49	-.46	-.37	-.30	-.21	-.14
161	.00	-.04	-.05	.01	.08	.15	.27	.36	.32	.21
171	.04	-.04	-.15	-.25	-.28	-.38	-.40	-.40	-.41	-.43
181	-.38	-.30	-.30	-.25	-.12	.00	.07	.11	.17	.24
191	.32	.39	.44	.39	.29	.14	.01	-.09	-.18	-.30
201	-.41	-.44	-.42	-.44	-.43	-.42	-.39	-.35	-.28	-.18
211	-.11	.01	.13	.21	.30	.39	.45	.48	.49	.44
221	.34	.22	.12	.01	.03	.05	.03	.03	.03	.00
231	-.01	-.02	.01	-.00	-.02	-.02	-.04	-.08	-.12	-.17
241	-.23	-.33	-.39	-.43	-.48	-.49	-.46	-.47	-.46	-.32
251	-.20	-.12	.00	.07	.18	.30	.42	.45	.44	.34
261	.18	.02	-.06	-.13	-.22	-.28	-.34	-.37	-.42	-.45
271	-.46	-.47	-.45	-.36	-.31	-.26	-.12	.00	-.01	-.04
281	.01	-.01	-.00	.06	.09	.08	.14	.17	.20	.21
291	.25	.28	.33	.35	.34	.29	.19	.03	-.09	-.16
301	-.24	-.34	-.39	-.42	-.43	-.46	-.48	-.45	-.44	-.39
311	-.31	-.21	-.10	.01	.13	.22	.29	.40	.45	.47
321	.47	.45	.38	.30	.21	.12	.06	.00	-.04	-.09
331	-.16	-.25	-.29	-.36	-.44	-.42	-.43	-.44	-.36	-.30
341	-.29	-.27	-.11	.00	-.04	-.02	.01	-.00	.05	.12
351	.20	.24	.30	.35	.38	.41	.43	.46	.39	.34
361	.26	.19	.12	.07	.00	-.05	-.12	-.19	-.25	-.30
371	-.36	-.33	-.32	-.27	-.27	-.26	-.21	-.17	-.10	-.04
381	.02	.08	.14	.24	.34	.42	.49	.48	.34	.19
391	.02	-.06	-.09	-.10	-.15	-.16	-.20	-.18	-.13	-.08
401	.00	-1.00	1.80	.00	.17	.00	.00	.00	.00	.00

RMS = 3.439 INCHES

TABLE 36



R039

Figure 42

5/27/78

AP629 16 NOV 76 ADDED TO THE DISK ON 24.MAR.77

NUMBER OF POINTS = 301

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.01	.1-	.11	.16	.21	.28	.31	.32	.28	.24
11	-.03	-.08	-.19	-.32	-.34	-.4[illegible]	-.39	-.33	-.35	-.[illegible]
21	-.32	-.38	-.41	-.44	-.42	-.38	-.29	-.17	-.06	.01
31	.12	.22	.26	.29	.28	.25	.18	.12	.04	-.[illegible]
41	-.22	-.33	-.38	-.37	-.35	-.33	-.32	-.35	-.36	-.[illegible]
51	-.43	-.45	-.38	-.33	-.29	-.17	-.09	-.05	-.03	-.03
61	-.09	-.15	-.22	-.25	-.25	-.20	-.12	-.05	.01	.02
71	-.02	-.04	-.09	-.19	-.2[illegible]	-.32	-.37	-.37	-.32	-.31
81	-.26	-.27	-.23	-.19	-.1[illegible]	-.10	-.01	.14	.24	.2[illegible]
91	.37	.43	.44	.46	.45	.40	.36	.28	.17	.08
101	-.01	-.09	-.18	-.19	-.15	-.10	-.06	-.11	-.12	-.[illegible]
111	-.05	.01	.13	.22	.25	.32	.40	.46	.42	.42
121	.44	.42	.41	.35	.31	.22	.16	.23	.25	.30
131	.36	.39	.40	.40	.43	.42	.33	.27	.23	.15
141	.10	.12	.10	.05	-.01	-.09	-.18	-.21	-.21	-.23
151	-.26	-.19	-.23	-.26	-.32	-.31	-.33	-.30	-.22	-.18
161	-.02	.10	.19	.30	.36	.41	.49	.46	.45	.47
171	.43	.37	.29	.25	.17	.02	-.09	-.14	-.25	-.33
181	-.40	-.42	-.48	-.48	-.43	-.39	-.44	-.38	-.28	-.22
191	-.12	.00	.06	.16	.27	.41	.45	.49	.44	.38
201	.31	.28	.30	.30	.25	.23	.28	.11	.01	-.[illegible]
211	-.11	-.12	-.11	-.06	-.04	-.03	-.01	.03	-.03	-.06
221	-.08	-.12	-.14	-.15	-.08	-.07	-.02	-.01	.02	-.04
231	-.05	.04	.04	.07	.12	.16	.13	.10	.00	-.04
241	-.06	-.06	.01	.05	.11	.13	.14	.12	.08	.06
251	.02	-.05	-.11	-.13	-.14	-.14	-.13	-.13	-.14	-.16
261	-.18	-.17	-.15	-.08	-.00	-.01	.03	.10	.06	.02
271	-.02	-.03	-.14	-.13	-.17	-.15	-.15	-.16	-.19	-.16
281	-.27	-.32	-.37	-.44	-.43	-.41	-.36	-.34	-.30	-.22
291	-.11	-.07	-.01	.01	-.03	-.03	.04	-.00	.02	.00
3[illegible]1	.00	-1.[illegible]	1.80	.00	.10	-.92	-.95	-.91	-.88	-.79

RMS = 3.005 INCHES

TABLE 37

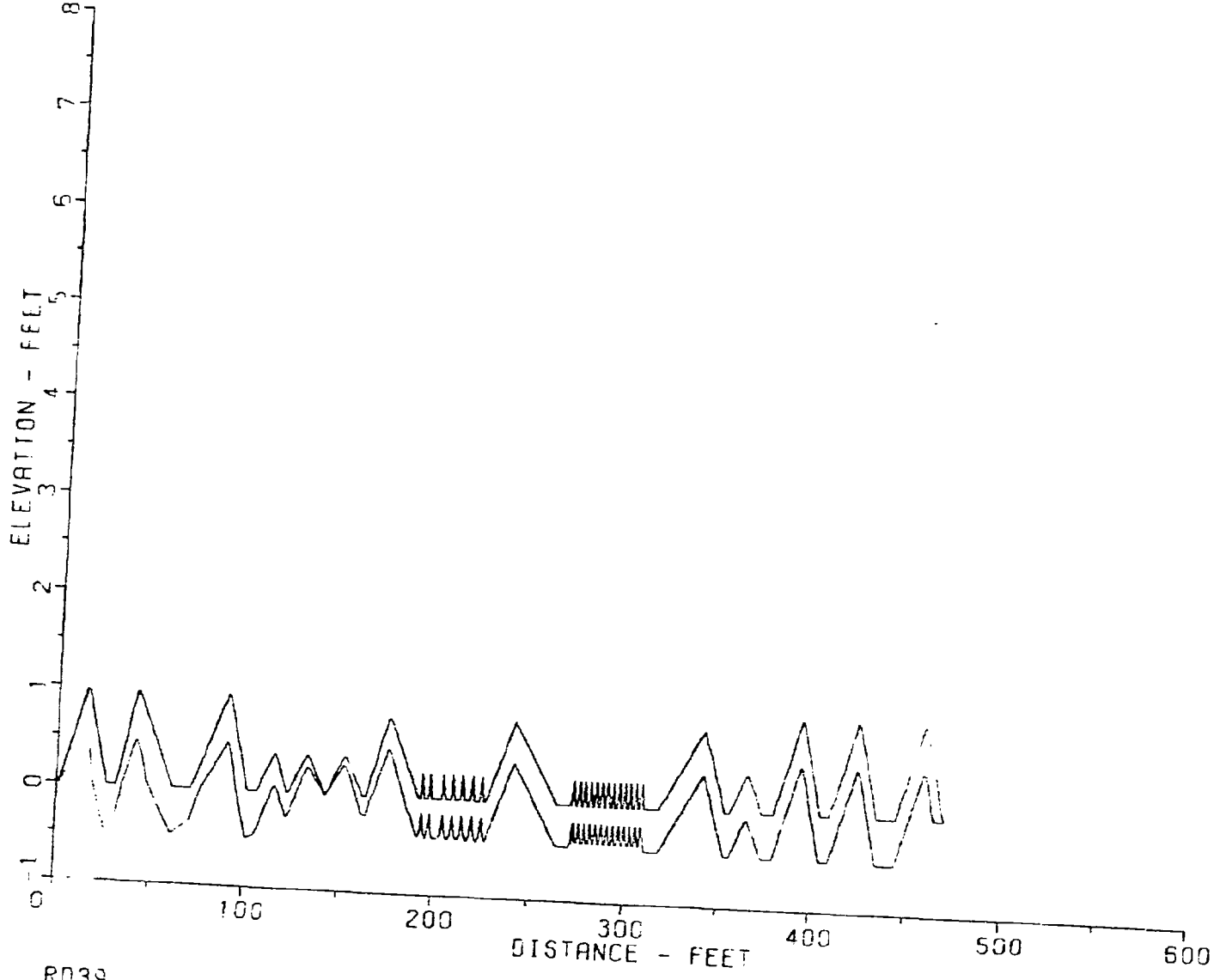


Figure 43

5/27/78

TABLE 38

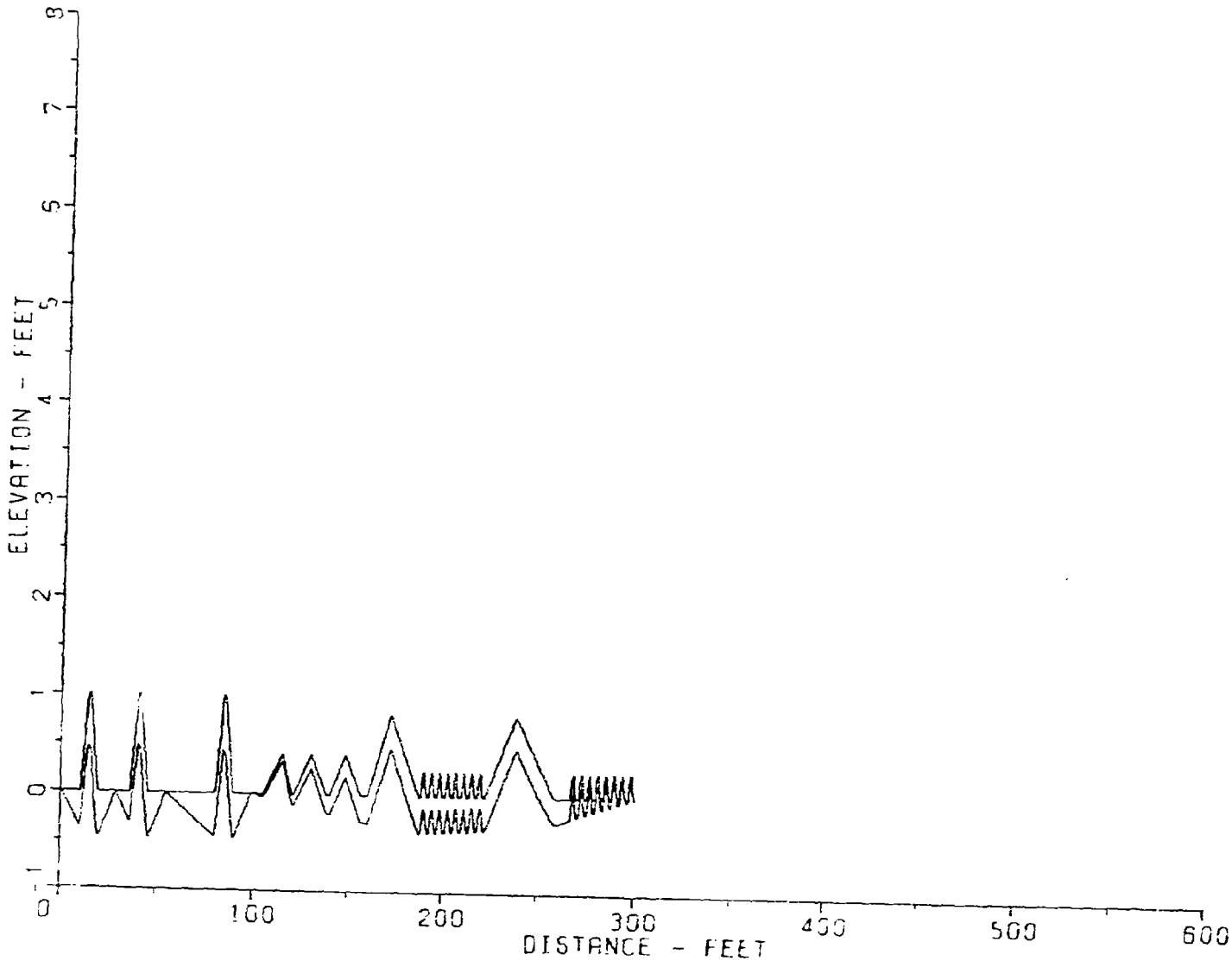
PROFILE 4 APR ADDED TO THE DISK ON 24.MAR.77

NUMBER OF POINTS = 469

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.03	.07	.10	.13	.15	.19	.22	.25	.29
11	.32	.35	.38	.42	.45	.39	.28	.14	.01	-.07
21	-.14	-.21	-.27	-.38	-.41	-.49	-.47	-.44	-.42	-.39
31	-.35	-.23	-.11	.00	.07	.14	.20	.27	.34	.41
41	.47	.44	.39	.31	.24	.16	.08	.01	-.03	-.05
51	-.11	-.15	-.19	-.22	-.26	-.29	-.33	-.37	-.41	-.44
61	-.48	-.46	-.43	-.44	-.42	-.41	-.39	-.38	-.36	-.35
71	-.33	-.28	-.20	-.13	-.06	.00	.03	.07	.10	.14
81	.17	.20	.25	.28	.31	.35	.38	.42	.45	.48
91	.45	.35	.23	.13	.01	-.07	-.16	-.24	-.33	-.41
101	-.49	-.49	-.47	-.46	-.45	-.44	-.38	-.32	-.27	-.21
111	-.16	-.10	-.04	.01	.06	.06	.01	-.03	-.09	-.14
121	-.20	-.25	-.24	-.18	-.12	-.07	-.01	.04	.10	.16
131	.21	.26	.27	.24	.22	.18	.15	.12	.08	.06
141	.02	-.01	.00	.03	.07	.10	.14	.17	.20	.24
151	.27	.30	.29	.24	.20	.14	.09	.04	-.02	-.07
161	-.13	-.18	-.20	-.20	-.14	-.08	-.01	.05	.11	.17
171	.24	.30	.36	.40	.40	.49	.43	.37	.31	.25
181	.19	.13	.06	.00	-.05	-.10	-.15	-.20	-.25	-.30
191	-.35	-.40	-.35	-.15	-.35	-.40	-.35	-.15	-.35	-.41
201	-.41	-.41	-.41	-.35	-.15	-.35	-.41	-.41	-.35	-.35
211	-.36	-.41	-.41	-.36	-.16	-.36	-.41	-.41	-.36	-.36
221	-.36	-.41	-.41	-.36	-.16	-.36	-.41	-.36	-.29	-.23
231	-.17	-.11	-.05	.01	.07	.13	.18	.23	.29	.35
241	.41	.34	.34	.30	.27	.23	.20	.16	.12	.09
251	.05	.01	-.02	-.06	-.09	-.13	-.17	-.20	-.24	-.26
261	-.32	-.36	-.39	-.43	-.43	-.43	-.43	-.43	-.43	-.43
271	-.43	-.38	-.18	-.38	-.38	-.18	-.38	-.38	-.18	-.38
281	-.38	-.18	-.38	-.38	-.18	-.38	-.38	-.19	-.38	-.38
291	-.19	-.38	-.38	-.19	-.38	-.38	-.19	-.39	-.39	-.19
301	-.39	-.39	-.19	-.39	-.39	-.19	-.39	-.39	-.19	-.39
311	-.44	-.44	-.44	-.44	-.45	-.45	-.45	-.44	-.41	-.34
321	-.34	-.31	-.27	-.23	-.20	-.16	-.12	-.09	-.05	-.02
331	.02	.06	.09	.13	.17	.20	.24	.27	.31	.34
341	.38	.31	.24	.18	.11	.04	-.03	-.10	-.17	-.24
351	-.31	-.38	-.45	-.46	-.46	-.46	-.41	-.36	-.31	-.26
361	-.21	-.17	-.12	-.07	-.07	-.12	-.17	-.21	-.26	-.31
371	-.36	-.41	-.46	-.47	-.47	-.47	-.47	-.47	-.46	-.39
381	-.32	-.25	-.19	-.12	-.06	.01	.08	.15	.22	.29
391	.36	.43	.50	.48	.39	.30	.29	.18	.01	-.10
401	-.18	-.28	-.37	-.47	-.48	-.48	-.48	-.48	-.47	-.40
411	-.33	-.26	-.20	-.14	-.07	.07	.07	.14	.21	.28
421	.36	.42	.49	.47	.39	.29	.20	.10	.01	-.09
431	-.18	-.29	-.37	-.47	-.46	-.48	-.48	-.48	-.48	-.48
441	-.48	-.48	-.48	-.48	-.41	-.34	-.27	-.20	-.14	-.07
451	.00	.07	.14	.21	.28	.35	.42	.49	.47	.00
461	.29	.20	.10	.01	-.00	.09	-.00	.01	.00	-1.00

RMS = 3.412 INCHES



R040

Figure 44

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TABLE 39 (Cont'd)

511	-.17	-.1[illegible]	-.[illegible]	-.23	-.24	-.26	-.28	-.27	-.27	-.27
521	-.26	-.[illegible]	-.26	-.25	-.25	-.25	-.24	-.24	-.24	-.23
[illegible]31	-.23	-.[illegible]	-.22	-.21	-.19	-.01	.04	-.01	-.00	-.19
541	-.2[illegible]	-.[illegible]	-.13	-.00	.07	.07	.00	-.12	-.17	-.17
551	-.15	-.04	.05	.10	.05	-.03	-.13	-.14	-.14	-.07
561	.05	.12	.13	.06	-.06	-.11	-.11	-.00	.02	.10
571	.15	.11	.03	-.06	-.08	-.08	-.02	.11	.18	.18
581	.11	-.[illegible]	-.06	-.05	-.04	.07	.16	.21	.16	.08
591	-.02	-.[illegible]	-.22	.04	.17	.24	.24	.17	.05	.00

RMS = 2.685 INCHES

REFERENCES

1. S. Heal and C. Cicillini, "Micro Terrain Profiles", ATAC report No. AD485664L, 1964

2. F. Hoogterp, "Digital/Analog Vehicle Ride Simulation", TACOM report No. 11705, 1972

3. "Moving-Head Disc Operating System", Hewlett-Packard Company 2116-91779, 1971

4. "Applications Programming Manual", PACER 100 Digital Computing System, EAI Associates Inc., 1976

5. "Moving-Head Disc Software System Manual", PACER 100 Digital Computing System, EAI Associates Inc., 1976

APPENDIX A

COMPUTER PROGRAMS

COMPUTER PROGRAMS

I. DETR - Detrends terrain and performs wheel trajectory calculations (see section 1 and Appendix C).

This program reads in a terrain from the disk, graphs it, takes out long uphill and downhill trends (subroutine DETRZ), digitally rolls a wheel over it (subroutine TRAJ) and then graphs the resulting trajectory of the bottom of the wheel. The wheel trajectory can then be listed on the line printer and punched out to paper tape.

DETR is only a control program which handles input, calls the subroutines and provides output.

II. DETRZ - Detrends a terrain so that it starts and ends at zero and stays within a specified limit.

The subroutine is supplied four parameters.

Y - Real array of terrain data

N - Number of data points

DELTA - Distance between data points

DISP - Maximum distance a data point can be above or below zero

Using the equation for a line

$$Yi = m\,Xi + b$$

and the distance of a point (Xj, Yj) from a line

$$D = \frac{|Yj - (m\,Xj + b)|}{\sqrt{1 + m^2}}$$

the subroutine uses Yi as one of the endpoints of a line and scans the terrain for another endpoint so that D will be less than DISP. Once this line is found, the new terrain elevations are calculated as being the distances from this line. The subroutine then uses the second endpoint as a starting endpoint and scans the rest of the terrain for another line. The entire terrain is detrended in this way and the subroutine exits.

III. TRAJ - Translates terrain displacements into wheel trajectories.

This subroutine is taken directly from reference 2. If a rigid tire is rolled over a non-deformable terrain, the bottom of the tire may not meet all of the data points.

The subroutine calculates the height of the bottom of the tire over each of the terrain data points. A tire of 42" diameter was used for all terrains to obtain maximum smoothing. For a discussion of the mathematics involved, see reference 2.

IV. LOAD - Loads a paper tape containing wheel displacements to a disk (see Appendix C).

The program expects the tape to have the five character name of the file as the first record, followed by the number of data points and sample interval in inches in a 2I5 format as the second record. The data points then follow, ten to a record in a 10I5 format. The program creates a disk file for each terrain.

V. SAMP - Sets up and runs a digital terrain simulation (see section 2 and Appendix C).

SAMP is structured as a control program which calls the three subroutines INPUT, BAYS and RUN. Communication of the control variables is accomplished through the two FORTRAN Common's; DATA and PARAM.

COMMON DATA

BEGIN (8) Contains the starting locations of up to eight terrains in the array SAMPLE.

SAMPLE (7500) Contains up to 7500 terrain data points.

COMMON PARAM

TERRA (8,8) $TERRA_{I,J}$ is the terrain number for $CHANNEL_I$ during $PHASE_J$.

SPACE (8,8) The time between data points in milliseconds.

NRUN (8,8) The number of times the terrain will be traversed.

DELAY (8,8) The number of milliseconds to wait before outputting the first data point.

NPHASE (8) $NPHASE_I$ is the number of terrains Channel I will cyclicly execute.

LAST (8) $LAST_I$ = .TRUE. if I is the last channel for a bay.

INIT (8) If $LAST_I$ is true then $INIT_I$ will be the first channel for that bay.

```
0001   $IN,L
0002   C
0003   C    THIS PROGRAM READS A TERRAIN FROM THE DISC.
0004   C    THE FIRST 15 WORDS ARE A DESCRIPTION OF THE TERRAIN.
0005   C    WORD 16 IS THE NUMBER OF POINTS IN THE TERRAIN.  THE
0006   C    REMAINING PORTION OF THE FILE CONTAINS FLOATING POINT
0007   C    VARIABLES.  THE FIRST OF THESE IS THE POINT SPACINGS IN INCHES
0008   C    THE REMAINDER OF THE FILE CONTAINS THE ELEVATIONS IN FEET
0009   C    OF THE TERRAIN.
0010   C
0011   C    THE TERRAIN IS THEN OUTPUT TO PAPER TAPE FOR INPUT TO PACER 600.
0012   C
0013         PROGRAM DETR
0014         INTEGER TITLE(29)
0015         REAL X(600),Y(600)
0016         DIMENSION A(6200),NA(1240),NAF(3)
0017         EQUIVALENCE (A,NA),(Y,A(14)),(TITLE,NA),(N,NA(21))
0018         CALL LPLOT(2)
0019       2 CONTINUE
0020         WRITE(1,10)
0021      10 FORMAT("ENTER TERRAIN FILE NAME:")
0022         READ(1,20) NAF
0023      20 FORMAT(2A2,A1)
0024         CALL ERASE
0025         CALL EXEC(14,1025,NA,128,NAF,0)
0026         DELTA=A(12) / 12.
0027         IF (N .GT. 600) N=600
0028         DO 99 J=1,N
0029            X(J)=J * DELTA
0030      99 CONTINUE
0031         ITER=(2*N)+26+128
0032         CALL EXEC(14,1025,NA(129),ITER,NAF,1)
0033         CALL LPLOT(1,0.,-1.,12.18,600.,0.)
0034         CALL SYMB(0.,-1.,.15,NAF,0.,5)
0035         CALL LPLOT(0,X,Y,N,1.0,,0.)
0036         CALL DETRZ(Y,N,DELTA,.5)
0037         CALL TRAJ(N,IFIX(A(12)),Y,42.)
0038         CALL LPLOT(0,X,Y,N,1.0,,0.)
0039         READ(1,20) NOYES
0040         IF (NOYES .NE. 2HYE) GO TO 2
0041         WRITE(6,30) NAF,TITLE,N,A(12),(NS,(Y(NS+I-1),I=1,10),NS=1,N,10)
0042      30 FORMAT(1H1,26X,2A2,A1,/,1HA,15A8," ADDED TO THE DISK ON ",A8,/,
0043        $"0NUMBER OF POINTS     = ",I4,/,
0044        $"0INTERVAL IN INCHES   = ",I4,/,
0045        $"2POINT",20X," ELEVATIONS IN FEE ",
0046        $    A2(/,I5,10F6.2))
0047         SUM=0.
0048         SUM2=0.
0049         DO 35 I=1,N
0050            SUM=SUM + Y(I)
0051            SUM2=SUM2 + Y(I)**2
0052            Y(I)=2 * Y(I)
0053      35 CONTINUE
0054         RMS=SQRT((SUM2 - SUM**2/N)/N) * 12.
0055         WRITE(6,38) RMS
0056      38 FORMAT("0RMS = ",G10.4," INCHES")
0057         CALL EXEC(3,1024)
0058         WRITE(4,40) NAF,N,A(12),(Y(I),I=1,N)
0059      40 FORMAT(2A2,A1,/,2I5,6P(/,10F5.3))
0060         GO TO 2
```

```
0001   FTN4,L
0002         SUBROUTINE DETRZ(Y,N,DELTA,DISP)
0003   C
0004   C      DETRENDS SO THAT:
0005   C         (1)  STARTING AND ENDING POINTS EQUAL ZERO
0006   C         (2)  MAXIMUM POINT < DISP
0007   C         (3)  MINIMUM POINT > DISP
0008   C
0009         REAL Y(1),DELTA,DISP,M,X,B
0010         INTEGER N,START,I,DIST,J
0011   C
0012         START=1
0013      10 CONTINUE
0014   C        SCAN UNTIL A LINE IS FOUND THAT 'FITS' THE DATA
0015            B=Y(START)
0016            DO 30 I=N,START+2,-1
0017               M=(Y(I)-Y(START)) / ((I-START)*DELTA)
0018               FACT=1. / SQRT(1. + M**2)
0019               DO 20 J=START+1,I-1
0020                  X=(J-START)*DELTA
0021                  D=ABS(Y(J)-(M*X+B)) * FACT
0022                  IF (D .GE. DISP) GO TO 30
0023      20        CONTINUE
0024   C            FOUND ONE
0025               GO TO 40
0026      30     CONTINUE
0027   C        NOW HAVE LONGEST LINE POSSIBLE
0028      40     CONTINUE
0029            M=(Y(I)-Y(START)) / ((I-START)*DELTA)
0032            FACT=1. / SQRT(1. + M**2)
0031            DO 50 J=START,I-1
0032               Y(J)=(Y(J) - (M*(J-START)*DELTA + B)) * FACT
0033      50     CONTINUE
0034            START=I
0035            IF (START .LT. N-1) GO TO 10
0036         Y(N)=0.
0037         IF (START .LT. N) Y(N-1)=0.
0038         RETURN
0039         END
0040         END$
**** LIST END ****
```

FORTRAN COMPILER REV. LEV. J00

```
      INTEGER FILE(3),INT,NUM,REC1(10)
      INTEGER TAPE,PLAT,NAME,WRIT,CLOS,DISK
      SCALED FRACTION REC(10)
      EQUIVALENCE (INT,REC1(1)),(NUM,REC1(10))
      DATA TAPE/4/, PLAT/22/, NAME/23/, WRIT/16/, CLOS/15/, DISK/'21/
      CALL QMOND(PLAT,DISK,1)
   10 CONTINUE
      READ(TAPE,20) FILE,NUM,INT
   20 FORMAT(2A2,A1,/,2I5)
      TYPE 20, FILE,NUM,INT
      CALL QMOND(NAME,DISK,FILE,3,10)
      CALL QMOND(WRIT,DISK,INT,NUM)
      JEND=NUM / 10
      DO 40 J=1,JEND
         READ(TAPE,30) REC
   30    FORMAT(10S5)
         CALL QMOND(WRIT,DISK,REC(1),REC(10))
   40 CONTINUE
      IEND=NUM - JEND*10
      IF (IEND .EQ. 0) GO TO 50
C     GET LAST RECORD
      READ(TAPE,30) (REC(I),I=1,IEND)
      CALL QMOND(WRIT,DISK,REC(1),REC(10))
   50 CONTINUE
      CALL QMOND(CLOS,DISK)
      GO TO 10
      END
```

PROGRAM SIZE = '270

CONSTANT TABLE

```
257    $5       OCT I 1
260    $17      OCT I 3
261    $62      OCT I 12
262    $214     OCT I 0
```

PROGRAM ALLOCATION

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
V I .01000	267	V I CLOS	6	V I DISK	7	A I FILE	10
V I I	266	V I IEND	265	V I INT	13	V I J	264
V I JEND	263	V I NAME	4	V I NUM	24	V I PLAT	5
A S REC	25	A I REC1	13	V I TAPE	2	V I WRIT	3

STATEMENT NUMBER LOCATIONS

44	.10	65	.20	152	.30	163	.40	251	.50		

EXTERNAL REFERENCES

```
C--THIS IS THE CONTROL PROGRAM FOR DIGITAL TERRAIN SIMULATION

FORTRAN COMPILER REV. LEV. J00


      INTEGER KEY,NCHAN,NUM(8),INIT(8)
      LOGICAL TERM
      REAL INT(8)
      COMMON /PARAM/ TERRA,SPACE,NRUN,DELAY,NPHASE,LAST,INIT
      INTEGER TERRA(8,8),SPACE(8,8),NRUN(8,8),DELAY(8,8),NPHASE(8)
      LOGICAL LAST(8)
      DATA KEY/2/
C--INITIALIZE ANALOG CONSOLE
      CALL QSHVIN(IERR,500)
      CALL QSSP(IERR)
      CALL QSCLR(IERR)
      TYPE 7
    7 FORMAT(80HENTER LOGICAL UNIT FOR INPUT:',/,
     $        80H KEYBOARD = 2',/,
     $        80H HSPT READER = 4',/)
      ACCEPT 10, KEY
   10 FORMAT(I1)
      TERM=KEY .EQ. 2
      CALL INPUT(TERM,KEY,INT,NUM)
      TYPE 20
   20 FORMAT(80HTERRAIN INPUT COMPLETE',/)
      CALL RAYS(TERM,KEY,NCHAN,INT,NUM)
      TYPE 30
   30 FORMAT(80HRAY SETUP COMPLETE',/)
      WRITE(120,40)
   40 FORMAT(80H1RAY PHASE TERRAIN SPACE RUNS CHANNEL DELAY')
      ISTART=1
      K=1
   50 CONTINUE
         DO 60 I=ISTART,8
            IF (LAST(I)) GO TO 70
   60    CONTINUE
         TYPE 61
   61    FORMAT(80HERROR 61')
         CALL EXIT
   70    CONTINUE
         NP=NPHASE(I)
         DO 81 J=1,NP
         WRITE(120,80) K,J,TERRA(J,I),SPACE(J,I),NRUN(J,I),
     $                    (L,DELAY(J,L),L=ISTART,I)
   80    FORMAT(2X,I1,4X,I1,6X,I1,4X,I5,1X,I4,4X,I1,4X,I5,
     $          7(/,33X,I1,4X,I5))
   81    CONTINUE
         IF (I .EQ. NCHAN) GO TO 90
         ISTART=I + 1
         K=K + 1
         GO TO 50
   90 CONTINUE
      CALL QSOP(IERR)
      CALL QSRUN(IERR)
      CALL RUN(NCHAN,NUM)
      END
```

FORTRAN COMPILER REV. LEV. 300

```
      SUBROUTINE INPUT(TERM,KEY,INT,NUM)
C--READS IN TERRAIN DATA
      LOGICAL TERM
      INTEGER KEY,NUM(8)
      REAL INT(8)
      SCALED FRACTION SAMPLE(5120)
      INTEGER BEGIN(8),START
      INTEGER NTERRA,NAME(3),NPLAT,PLAT,POST,READ,DISK,REC1(10)
      EQUIVALENCE (INT1,REC1(1)),(NUM1,REC1(10))
      COMMON /DATA/ BEGIN,SAMPLE
      DATA START/1/
      DATA PLAT/22/, POSI/21/, READ/17/, DISK/21/
      IF (TERM) TYPE 9
    9 FORMAT(8@ENTER NUMBER OF TERRAINS:',/)
      READ(KEY,10) NTERRA
   10 FORMAT(I1)
      CALL QMOND(PLAT,DISK,1)
      DO 40 I=1,NTERRA
         IF (TERM) TYPE 19, I
   19    FORMAT(8@ENTER FILE NAME FOR TERRAIN NUMBER:',I2,/)
         READ(KEY,20) NAME
   20    FORMAT(3A2)
         CALL QMOND(POSI,DISK,NAME)
         CALL QMOND(READ,DISK,INT1,NUM1)
         INT(I)=FLOAT(INT1)/12./5280.
         NUM(I)=NUM1
         BEGIN(I)=START
         DO 30 J=1,NUM1,10
            CALL QMOND(READ,DISK,SAMPLE(START),SAMPLE(START+9))
            START=START + 10
   30    CONTINUE
   40 CONTINUE
      RETURN
      END
```

PROGRAM SIZE = 1332

CONSTANT TABLE

```
317    $5       OCT I 1
320    $214     OCT J 12
321    $322     OCT R 60000
322             OCT   4
323    $327     OCT R 51200
324             OCT   15
```

PROGRAM ALLOCATION

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
V I .U1000	327	V I .U1210	331	V I DISK	10	V I I	306
A U INT	2	V I INT1	14	V I J	330	V I KEY	1

FORTRAN COMPILER REV. LEV. 100

```
      SUBROUTINE BAYS(TERM,KEY,NCHAN,INT,NUM)
C--SETS UP A MAXIMUM OF FOUR BAYS
      COMMON /PARAM/ TERRA,SPACE,NRUN,DELAY,NPHASE,LAST,INIT
      LOGICAL TERM
      INTEGER KEY,NCHAN,NUM(8),INIT(8)
      INTEGER I,J,K,N,NAXLES,TNUM,NTERRA,RUNS
      REAL L(8),L1,D,ANGLE,MPH,MILES,PI,V,WAIT
      INTEGER TERRA(8,8),SPACE(8,8),NRUN(8,8),DELAY(8,8),NPHASE(8)
      LOGICAL LAST(8)
      REAL INT(8)
      DATA PI/3.14159/, ISTART/1/
      TAN(T)=SIN(T) / COS(T)
      OPP(H,A)=SQRT(H**2 - A**2)
      ACOS2(A,H)=ATAN2(OPP(H,A),A)
   10 FORMAT(I1)
      IF (TERM) TYPE 20
   20    FORMAT(80HENTER NUMBER OF BAYS:',/)
      READ(KEY,10) NBAYS
      DO 130 K=1,NBAYS
         IF (TERM) TYPE 30, K
   30       FORMAT(80HENTER NUMBER OF AXLES FOR BAY',I2,1H:,/)
         READ(KEY,10) NAXLES
         NCHAN=ISTART + 2*NAXLES - 1
         DO 60 N=1,NAXLES
            IF (TERM) TYPE 40, N
   40          FORMAT(80HENTER DISTANCE(FT) FOR AXLE',I2,1H:,/)
            READ(KEY,50) D
   50       FORMAT(E6.2)
            L(N)=D / 5280.
   60    CONTINUE
         L1=L(1)
         L(1)=0.
         IF (TERM) TYPE 70, K
   70       FORMAT(80HENTER NUMBER OF PHASES FOR BAY',I2,1H:,/)
         READ(KEY,10) NTERRA
         DO 120 J=1,NTERRA
            IF (TERM) TYPE 80
   80          FORMAT(80HENTER TERRAIN,ANGLE(DEGREES),MPH,MILES,:',/)
            READ(KEY,90) TNUM,ANGLE,MPH,MILES
   90       FORMAT(I1,1X,3E6.2)
            THETA=ANGLE * PI/180.
            D=L1 * TAN(THETA)
            V=MPH/3600. / 1000.
            WAIT=AINT(INT(TNUM) / (V*COS(THETA)) + .5)
            RUNS=IFIX(MILES/(V*WAIT) / FLOAT(NUM(TNUM)) + .5)
            DO 100 I=ISTART,NCHAN
               TERRA(J,I)=TNUM
               SPACE(J,I)=IFIX(WAIT)
               NRUN(J,I)=RUNS
               NPHASE(I)=NTERRA
               LAST(I)=.FALSE.
  100       CONTINUE
            LAST(NCHAN)=.TRUE.
            INIT(NCHAN)=ISTART
```

```
                I=ISTART
                DO 110 N=1,NAXLES
                   DELAY(J,I)=IFIX(L(N)/V + .5) + 2000
                   DELAY(J,I+1)=IFIX((L(N)+D)/V + .5) + 2000
                   I=I + 2
  110           CONTINUE
                THETA=ACOS2(INT(TNUM),V**WAIT)
                ANGLE=THETA * 180./PI
                D=INT(TNUM) / COS(THETA)
                MPH=D / (WAIT/1200./3600.)
                MILES=FLOAT(RUNS)*FLOAT(NUM(TNUM))*D
                TYPE 111, K,J,ANGLE,MPH,MILES
  111           FORMAT(A8HCOMPUTED FOR BAY',I2,8H, PHASE',I2,/,
     $                 F6.2,9H DEGREES ,F6.2,5H MPH ,F6.2,6H MILES)
  120       CONTINUE
            ISTART=NCHAN + 1
  130   CONTINUE
        RETURN
        END
```

PROGRAM SIZE = 1526

CONSTANT TABLE

```
1431   $5        OCT I 1
1432   $12       OCT I 2
1433   $144      OCT I 10
1434   $543      OCT R 51200
1435             OCT   15
1436   $55C      OCT R 0
1437             OCT   200
1440   $613      OCT R 55000
1441             OCT   10
1442   $602      OCT R 70200
1443             OCT   14
1444   $625      OCT R 76400
1445             OCT   12
1446   $537      OCT R 40000
1447             OCT   9
1450   $722      OCT L 0
1451   $727      OCT L 100000
1452   $721      OCT I 3720
```

PROGRAM ALLOCATION

```
     NAME     ADR          NAME     ADR          NAME     ADR          NAME     ADR
V I .U1003   1512     V I .U1013   1523     V R .U2000   1501     V R .U2001   1503
V R .U2002   1507     V R .U2003   1524     V R .U2011   1505     V R .U2013   1510
V R .U2022   1517     V R .U2033   1521     V R ANGLE    1467     V R D        1466
V I I        1453     A R INT      3        V I ISTART   7        V I J        1454
V I K        1455     V I KEY      1        A R L        10       V R L1       1463
V R MILES    1473     V R MPH      1471     V I N        1456     V I NAXLES   1457
V I NBAYS    1511     V I NCHAN    2        V I NTERRA   1461     A I NUM      4
V R PI       5        V I RUNS     1462 102 V L TERM     0        V R THETA    1463
```

FORTRAN COMPILER REV. LEV. J04

```
      SUBROUTINE RUN(NCHAN,NUM)
      INTEGER NCHAN,NUM(8),INIT(8)
      SCALED FRACTION SAMPLE(5120)
      INTEGER BEGIN(8)
      INTEGER TERRA(8,8),SPACE(8,8),NRUN(8,8),DELAY(8,8),NPHASE(8)
      LOGICAL LAST(8)
      INTEGER NTERRA,START,NOW,OLD
      INTEGER PHASE(8),TIME(8),INDEX(8),NSEC(8),FIRST(8),STOP(8),
     $        RNUM(8)
      COMMON /PARAM/ TERRA,SPACE,NRUN,DELAY,NPHASE,LAST,INIT
      COMMON /DATA/ BEGIN,SAMPLE
      DATA START/1000/, PHASE/8*1/
      DO 65 I=1,NCHAN
         NTERRA=TERRA(1,I)
         NSEC(I)=SPACE(1,I)
         L=BEGIN(NTERRA)
         INDEX(I)=L
         FIRST(I)=L
         STOP(I)=L + NUM(NTERRA)
         RNUM(I)=NRUN(1,I)
         TIME(I)=DELAY(1,I)
   65 CONTINUE
      CALL QWTIMT(START,IERR)
C--MAIN LOOP
   70 CONTINUE
         CALL QRTIMI(NOW,IERR)
         OLD=START=NOW
         CALL QWTIMT(START,IERR)
C--SCAN CHANNELS
         DO 80 I=1,NCHAN
            TIME(I)=TIME(I) - OLD
            IF (TIME(I) .GT. 0) GO TO 80
C--OUTPUT DISPLACEMENT
            J=INDEX(I)
            CALL QWJDAS(SAMPLE(J),I-1,IERR)
            J=J+1
            TIME(I)=NSEC(I)
            IF (J .NE. STOP(I)) GO TO 75
C--FINISHED RUN
            RNUM(I)=RNUM(I)-1
            IF (RNUM(I) .GT. 0) GO TO 74
C--FINISHED PHASE
            J=PHASE(I)+1
            IF (J .GT. NPHASE(I)) J=1
            NTERRA=TERRA(J,I)
            NSEC(I)=SPACE(J,I)
            L=BEGIN(NTERRA)
            FIRST(I)=L
            STOP(I)=L + NUM(NTERRA)
            RNUM(I)=NRUN(J,I)
            PHASE(I)=J
            IF (.NOT. LAST(I)) GO TO 73
C--RAY HAS FINISHED PHASE
            KI=INIT(I)
```

```
PAGE  2       C--OUTPUTS DIGITAL TERRAINS

              DO 72 K=KI,I
                 TIME(K)=DELAY(J,K)
   72         CONTINUE
              GO TO 74
C--SET FOR LONG WAIT
   73         CONTINUE
              TIME(I)=30000
   74         CONTINUE
              J=FIRST(I)
   75         CONTINUE
              INDEX(I)=J
   80       CONTINUE
            GO TO 70
         END
```

PROGRAM SIZE = 1153

CONSTANT TABLE

```
1134   $5        OCT I 1
1135   $50       OCT I 10
1136   $454      OCT I 0
1137   $531      OCT I 72460
```

PROGRAM ALLOCATION

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
V I .U1000	1144	V I .U1010	1145	A I FIRST	43	V I I	1143
V I TERR	1147	A I INDEX	23	V I J	1150	V I K	1152
V I KI	1151	V I L	1146	V I NCHAN	0	V I NOW	1141
A I NSEC	33	V I NTERRA	1140	A I NUM	1	V I OLD	1142
A I PHASE	3	A I RNUM	63	V I START	2	A I STOP	53
A I TIME	13						

COMMON ALLOCATION

/PARAM /ALLOCATION LENGTH = 1430

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
A I TERRA	0	A I SPACE	100	A I NRUN	200	A I DELAY	300
A I NPHASE	400	A L LAST	410	A I INIT	420		

/DATA /ALLOCATION LENGTH = 112010

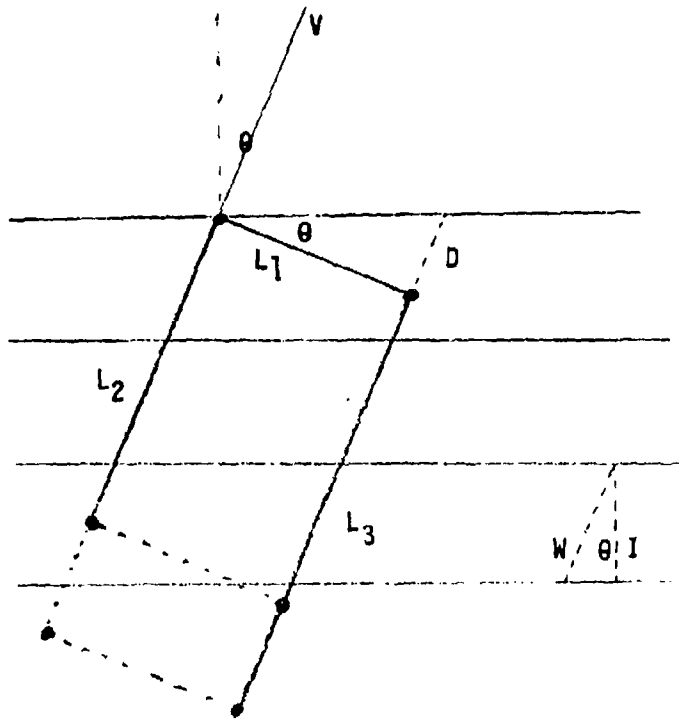
NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
A I BEGIN	0	A S SAMPLE	10				

STATEMENT NUMBER LOCATIONS

APPENDIX B

VEHICLE GEOMETRY

TRUCK CROSSING
WASHBOARD



$\tan \theta = \frac{D}{L_1} \rightarrow D = L_1 \tan \theta$

$\cos \theta = \frac{I}{W} \rightarrow W = I/\cos \theta$

$T_W = \frac{W}{V} \rightarrow T_W = \frac{I}{V \cos \theta}$

AND:

$T_{L1} = 0 \qquad T_{R1} = \frac{D}{V}$

$T_{L2} = \frac{L_2}{V} \qquad T_{R2} = \frac{L_2 + D}{V}$

$T_{L3} = \frac{L_3}{V} \qquad T_{R3} = \frac{L_3 + D}{V}$

θ - Angle of traversal in degrees ($0^o \leq \theta < 90^o$)

V - Velocity in miles per millisecond

I - Sample interval in miles

T_W - Time between samples in milliseconds

T_{SN} - Initial delays in milliseconds

APPENDIX C

OPERATING PROCEDURES

OPERATING PROCEDURES

I. Hewlett-Packard 2116B

A. DETR - Performs detrending and wheel trajectory calculations (see section 3 and Appendix A)

1. The program first asks for parameters necessary for graphing. When the title is asked for, the user should supply blanks (the file name is used as the title).

2. After plotting the terrain profile, the program performs the necessary calculations and plots the resulting wheel displacements.

3. By entering YES after the wheel trajectory is plotted, a listing and paper tape of the wheel profile are produced.

II. PACER 100

A. LOAD - Loads paper tapes to disk.

1. The program continuously loads paper tape without operator intervention.

2. The computer should be halted at the end of the tape.

B. SAMP - Runs digital simulation (see section 2 and Appendix A)

1. The EAI 580 should be in digital mode. The program will initiate POT-SET and Logic CLEAR. Hydraulics should be running but with inputs at zero.

2. In the terrain input phase enter the one to six character name of each file.

3. The distance for the first axle is its width. The distances for the following axles are the number of feet from the first axle.

4. The format for TERRAIN, ANGLE, MPH, MILES is (I1, 1X, 3E6.2). Free field input may be used if all commas and decimal points are supplied (see example).

5. The computer will go to OPERATE and logic RUN when the bay setup is complete. The hydraulics should be brought slowly in to verify proper operation.

6. To terminate, shut down hydraulics and then HALT computer.

```
#L,SAMP2,21
SAMP2 CI P1
LD
#G,1000

ENTER LOGICAL UNIT FOR INPUT:
KEYBOARD = 2
HSPT READER = 4
2
ENTER NUMBER OF TERRAINS:
3
ENTER FILE NAME FOR TERRAIN NUMBER: 1
RD05
RD05 DA P1

ENTER FILE NAME FOR TERRAIN NUMBER: 2
RD06
RD06 DA P1

ENTER FILE NAME FOR TERRAIN NUMBER: 3
RD07
RD07 DA P1

TERRAIN INPUT COMPLETE

ENTER NUMBER OF BAYS:
1
ENTER NUMBER OF AXLES FOR BAY 1:
3
ENTER DISTANCE(FT) FOR AXLE 1:
7.,
ENTER DISTANCE(FT) FOR AXLE 2:
13.,
ENTER DISTANCE(FT) FOR AXLE 3:
17.5,
ENTER NUMBER OF PHASES FOR BAY 1:
3
ENTER TERRAIN,ANGLE(DEGREES),MPH,MILES,:
3,45.,10.,.25
COMPUTED FOR BAY 1, PHASE 1
 44.75 DEGREES  10.00 MPH     .25 MILES
ENTER TERRAIN, ANGLE(DEGREES),MPH,MILES,:
2,45.,20.,.25
COMPUTED FOR BAY 1, PHASE 2
 44.75 DEGREES  20.00 MPH     .23 MILES
ENTER TERRAIN,ANGLE(DEGREES),MPH,MILES,:
1,45.,30.,.25
COMPUTED FOR BAY 1, PHASE 3
 44.75 DEGREES  30.00 MPH     .25 MILES
BAY SETUP COMPLETE
```

RUN	PHASE	TERRAIN	SPACE	RUNS	CHANNEL	DELAY
1	1	2	56	3	1	2220
					2	2477
					3	2856
					4	3364
					5	3193
					6	3670
1	2	2	48	2	1	2000
					2	2236
					3	2443
					4	2682
					5	2597
					6	2835
1	1	1	14	7	1	2200
					2	2159
					3	2265
					4	2456
					5	2309
					6	2557

SAMPLE OF COMPUTER PRINTOUT

SPACE: Milliseconds between data-points

RUNS: Number of times terrain is traversed

DELAY: Initial delay in milliseconds

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Analog/Digital Computers
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Road profiles available for digital terrain simulation at TARADCOM are cataloged. The terrain simulation program for the PACER 100/EAI 580 Hybrid computer system is described. The terrain simulation program was developed to better utilize the hybrid computing system when it is required to run several vehicles over known terrains at different speeds for varying lengths of time. The operator can interactively setup the test environment or feed in a prepared paper tape. Terrains are stored on disks and vary from profiles of actual test courses to synthesized forcing functions. Development and operation of the program are described and possible future refinements are explored.

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